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Industrial districts' evolution and technological regimes: Italy and Taiwan

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Abstract

This paper investigates some plausible models of evolution of industrial districts (IDs) and clusters in light of the peculiar current features of technology and technological change. An insightful explanation of the variety of possible evolution of industrial clusters is provided focusing on the concept of '*technological regimes*'. Within this interpretative framework, the authors carried out original field studies and survey questionnaires in Italy and Taiwan to gather microeconomic evidence on the restructuring efforts and sources of competitiveness of selected small- and medium-sized enterprises (SMEs). The shift in the technological paradigm, that applies to all sectors, requires a substantial industrial reorganisation. Firms traditionally operating within industrial districts need to reorganise their knowledge linkages from a cluster-based approach to a global and broader approach.

A key explanation of the success of SMEs competing in globalized high-tech industries, supported by our survey evidence, is the co-evolution of domestic and international knowledge linkages. Inter-firm and inter-institution linkages need to be built to provide local SMEs with the necessary externalities to cope with the dual challenge of knowledge creation and internationalisation. In Taiwan, this took the form of global production networks.

JEL classification: O32; O33; R12

Keywords: Clusters; Industrial districts; Technological regimes; Global production networks; Globalization; Agglomeration

1. Introduction

For several decades, in many countries and industries, enterprise clustering has offered a competitive alternative to the advantages achieved through a larger production scale, and through the ensuing economies of scale.[2]

The typical uniformity in the growth process of small- and medium-sized enterprise (SME) systems, experienced during the 1970s and the 1980s in Italian local systems, has come to an end (Carminucci and Casucci, 1997). New diversified and 'idiosyncratic' patterns of growth have been observed, and the range of options chosen expands when attempting to draw international comparisons. No common and unidirectional development pattern has proved valid anymore, and different avenues have been followed to face the new competitive challenges posed by the globalisation of markets and technology. It appears especially useful to remember the insightful remark of the main scholar of the industrial districts (IDs):

> …particularly in the Italian experience, the industrial district has often proved to be rather a 'stage' in one of the possible different paths of industrialization (Becattini, 1987).[3]

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[2] On this evidence, see the studies in Pyke et al. (1991) and Guerrieri et al. (1998).

[3] According to Becattini, Marshall properly distinguishes between different geographical levels of analysis, the industrial district showing a lower degree both in the density of territorial agglomeration and in

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The aim of this paper is to investigate some plausible models of evolution of enterprise clusters and industrial districts and provide an explanation in light of the peculiar features of technology and technological change. This task is made even harder by the variety of visions on the notion of ID in the literature, and by the very vast array of experiences of enterprise clusters and agglomerations that have been recorded world-wide. In fact, some "concrete instances of industrial districts are closer to a set of stylised facts than a model" (Humphrey, 1995, p. 152), and none of the IDs is strictly equal to another, as also demonstrated by the variety of product specialisations, degree of complexity of organisational and network systems and cultural and social backgrounds. Moreover, the scope and variety of inter-firm organisations are continuously expanding in relation to the globalisation of technology and the increasing internationalisation of economic activities.

To this aim, we shall first briefly review the literature on the typology of IDs, and in general on the variety of visions on the phenomenon of enterprise clustering. We shall notice how little attention has been paid to the transformation of IDs, and to models geared to explain the different responses in terms of organisation of inter-firm linkages, within and outside the cluster.[4]

Among the crucial factors explaining the evolution of the clusters' industrial organisation are the external inducements derived from market competition and changes in demand, and from technology and technological change. The latter appears especially important in the current world. The changes in technological paradigms and trajectories that crucially affect the foundations of competitiveness are increasingly shaped by the internationalisation process,[5] and contribute to determine the prevailing form of company strategy, especially inter-firm attitudes and the industrial organisation within an enterprise cluster. Interestingly, this dimension has often been underplayed in the studies of industrial agglomeration.

In order to explain the pattern of success, the similarities and the differences, and the possible evolution of enterprise clusters,[6] we shall explore and compare selected experiences in Italy and Taiwan.

Importantly, it is the whole enterprise group that achieves this transformation, not necessarily the individual firm. Through such an evolution, a cluster would be renewing its sources of competitiveness, initially based on lower input costs, some (limited) horizontal linkages with a blend of competition and collaboration and mainly local external economies and "collective efficiency".

The following gives an outline of how this paper is structured. In Section 2, some of the main categorisations of clusters and IDs proposed in the literature are presented and discussed. They seldom focus on the possible evolutionary paths of each model of industrial organisation, as explained in Section 3. Changes in such regimes are in fact inducing different responses in different parts of the world, as explored in Sections 4 and 5, which report the results of a recent field research conducted in Italy and Taiwan. Section 6 concludes and draws some comparisons from the cases analysed.

2. Categorisations of clusters and industrial districts and the dynamics of industrial organisation

The literature on enterprise clusters and industrial districts is sizeable, and was started by the classical contribution of Alfred Marshall (1896) on the importance of external economies for industrial districts. Then, following the increasing complexity and variety of real world inter-firm organisation, several categorisations of industrial clusters and districts have been proposed, often grouping widely different realities under the same label.

In a study of the Italian evidence on how production is spatially organised, Garofoli (1991) proposed a typology of models of local development that has been rather influential on later work. This classification introduced concepts such as *local production systems* and *system areas*, and described the rise in the complexity of the local system that may occur, with inter-firm and inter-institution synergies growing widespread and effective.

Another interesting categorisation explicitly introduces asymmetries among the clustered enterprises and it is centred on the concept of '*leader firms*' and of the *constellation* surrounding them (Lorenzoni, 1990). Interestingly, in all cases, there is no perfect symmetry among the various agents operating in the cluster, but each agent may play a distinct role, and one (or more of them) leads the cluster in terms of organisation, innovation, and/or finance. The extent of the leadership is more marked the more the system moves towards a 'network' or a 'group'.

Markusen (1996a) broadens the picture to include several different forms of industrial organisation within the definition of an industrial district. She argues that the emergence of 'sticky places' in a 'slippery space'—characterised by dramatically improved communications, and increasingly mobile production factors and

the weight of services with respect to the urban system, and a monosectoral character along with a lesser degree of complexity with respect to the industrial region. The significance of different territorial units clearly depends on the aim of the investigation, although the choice of the district is probably the most appropriate to help understand the "endogenous sources of industrial dynamism" (Becattini, 1987, p. 32).

[4] An interesting exception is Castellano (1999).

[5] See Ernst and Guerrieri (1998) for evidence on the electronics sector, and Guerrieri et al. (2001).

[6] See Bagella (1996) for cases in Latin America.

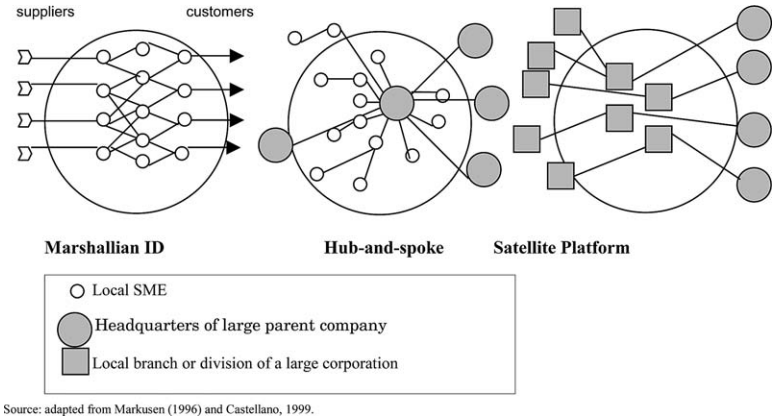

Fig. 1. Typology of industrial districts.

enterprises—may be related to numerous variants of industrial districts. Thus, she opts for an expansive connotation of industrial district which does not confine it to the most common usage (e.g. the Marshallian—'Italian' variant—district). Therefore, the definition of ID utilised is the following:

> …an ID is a sizeable and spatially delimited area of trade-oriented economic activity which has a distinctive economic specialization, be it resource-related, manufacturing, or services (Park and Markusen, 1994).[7]

It is clear that adopting this definition implies considering a cluster or an industrial district essentially as a synonym to describe a reality of a location that provides "…the *glue* that makes it difficult for smaller firms to leave, encouraging them to stay and expand, and attracting newcomers into the region" (Markusen, 1996a, p. 294).

The conceptualisation proposed focuses on the following essential classificatory principles: firm-size, inter-firm relations and internal versus external orientations (Fig. 1).

The concept of the *Industrial District*, and its *Italian Variant*, owes its popularity to Alfred Marshall, who first noted the external economies due to the co-location of small firms, and to several scholars who resuscitated his insights to explain the superior economic performance of regions such as the Third Italy, or Silicon Valley in the US, in the 1980s and 1990s. They emphasised concepts such as the 'industrial atmosphere',[8] the local long-term socio-economic relationships among local firms, involving trust and a blend of competition and collaboration, and the role of local institutions, the latter especially in the Italian version.[9]

The second category of ID proposed by Markusen and empirically detected in the US and elsewhere is the *hub-and-spoke district* (Markusen, 1996a). It occurs where one or more firms/facilities act as anchors or hubs to the regional economy, with suppliers and related activities spread around them like the spokes of a wheel. A single large—often vertically integrated—firm (e.g. Boeing in Seattle and Toyota in Toyota City) or several large firms in one or more sectors (such as Ford, Chrysler and GM in Detroit, or the biopharmaceutical industry in New Jersey) may act as hubs, surrounded by smaller and dominated suppliers. The spokes may represent strong ties, as in the previous example, or loose ties, such as the externalities enjoyed as agglomeration economies derived from proximity.[10] The large hub firms often have substantial links to suppliers, competitors and customers outside the district. This may represent an interesting dynamic feature of this model, insofar as these 'long arms' act as 'sensors' for innovation and creativity in other locations and thereby enable the transfer of new ideas and technology to the home region. However, such long arms may also inform the hub company of the potential benefits and opportunities elsewhere and drive the major firm out of the region. Co-operation among competitors within this form of ID is remarkably lacking, and inter-firm relationships occur between the hub firms and their (often long-term) suppliers. However, the

[7] Her definition of ID is clearly different from the definition proposed and utilised by the Italian (mainly Florentine) school (Becattini, Bellandi, Dei Ottati, Sforzi and others), as she acknowledges several different institutional set-ups as having the essential features of a 'district'. In fact, her typology gathers together several different forms of organisation of production where a common geographical localisation plays a central role. As a consequence of this very broad approach, the 'Italian' version of ID ends up being only one possible form of inter-firm organisation, very close to the original Marshallian idea.

[8] See Pietrobelli (1998), for an empirical test of the concept of 'industrial atmosphere' in a sample of Italian IDs.

[9] See Guerrieri et al. (1998) for a survey.

[10] An example may be provided by the local skilled labour pool (or cadre of business services) built up by a large firm that facilitates the start up and growth of SMEs in the shadow of the major firm (Markusen, 1996b).

terms of co-operation are always set by the hub firm. Thus, in principle, the hub might even be interested in deliberately playing off one supplier against another as a way of getting more favourable conditions.

In Northern Italy, this sort of agglomeration has developed in Piedmont around the automotive producer FIAT and its intermediate goods and service suppliers, and around Olivetti in Ivrea.

In principle, within this type of cluster, an interesting development process may be envisaged. The spark could be represented by the agglomeration of skilled labour and business services around the hub, with the spoke firms setting up alternative and independent links and benefiting from the agglomeration economies generated by the district. In this hypothesis, the presence of a large hub firm with several activities and multiple linkages with other firms and providers would foster (or even *lead*) the ID to venture into new sectors, diversifying away from the traditional specialisation. This is likely to occur more frequently when hubs are active in more than one industry, and may explain the evolution of clustering and IDs and the reorganisation of their network of linkages.

The *satellite platform* is the third type of ID described by Markusen: it consists of a congregation of branch facilities of externally based multi-plant firms. It is often induced by the policies of national/local governments to stimulate regional development. Key investment decisions are made out of the ID, and tenants of the satellite platform must be able to more or less 'stand alone', that is, to be spatially independent from upstream or downstream operations as well as from the agglomeration of other competitors and suppliers in the same area. There tends to be minimal collaboration among platform firms, often engaged in different activities and industries. Differently from what happens in the hub-and-spoke version, the large, often multinational, corporation is not locally based. Constraints to the development of this type of ID derive from the lack of local sources of finance, technical expertise, business services, 'patient capital' and the industry-specific business associations that may provide shared resources and services.[11]

When industrial activities are 'anchored' to a region by a public or non-profit entity, such as a military base, a university or a concentration of public laboratories or government offices, then a *state-anchored district* may emerge. The local business structure is dominated by the presence of such facilities, which follow a logic that is different from private-sector firms' views. Politics may play a central role in the development of such a form of ID. Indigenous firms will play a smaller role here than in the previous forms of ID. However, some new SMEs may emerge out of specialised technology transfer (e.g. via universities) or business services provided by (or spilling over from) the anchor institution. As for the satellite platform, this type of ID occurs less frequently in Italy than in larger countries such as the US but may represent a useful way to portray an ID emerging from a government-planned initiative. Thus, the many examples of 'business parks', 'science parks' or the like, being set up in developed and developing countries through a government initiative to finance and promote a local institution such as a training centre, a quality control agency, a technology diffusion centre, a laboratory or a testing and R&D facility, may fall within this category.

In this class of ID, the growth of local SMEs, and their diversification into various industries, is likely to depend on several specific features of the ID, such as the specificities of the prevailing industry, the technology in use and its transferability from the 'anchor' to local firms, and the existence of local additional competitive factors (e.g. local demand or distribution channels, pools of skilled labour and the presence of 'patient capital').

Of course *a real-world cluster may be an amalgam of one or more types*.[12] In order to simplify these categories even further, by singling out one key characteristic, we may explore whether a form of leadership is present. At the cost of lacking precision, firms may tend to share a geographical agglomeration along three broad modalities:

1. (*Casual*) *geographical clustering of firms*, with occasional inter-firm linkages, no (little) experience of co-operation, non-existent or little developed local institutions;
2. *Marshallian* (*Italian*) *ID*, with smoother inter-firm transactions, much better developed practices of co-operation, more developed and effective local institutions, economies of scale at the district level made possible by substantial enterprise specialisation, deep integration between economic activities and the local socio-cultural fabric;
3. *Enterprise network with some form of leadership* prevailing, be it a hub-and-spoke, leader–followers, or satellite platform, with the leader providing the strategic services and impetus for diversification into different products and sectors, with reorganisation of production and new relationships with firms, local institutions, and factor and product markets.

[11] This type of ID appears more adequate to portray the situation in the US than in Italy or other smaller industrialising countries. Moreover, its prospects of endogenous development appear remarkably conditioned by externally made decisions.

[12] For instance, Silicon Valley hosts an industrial district in electronics (Saxenian, 1994), some important hubs (Lockheed, Hewlett Packard, Stanford University), and platform branches of large corporations (IBM, Oki, Hyundai, Samsung, NTK Ceramics), but it is also the fourth largest recipient of military spending in the US.

It is important to note that these are *not* necessarily sequential stages, as clusters may remain persistently different, depending on industry or country characteristics or historical circumstances and 'lock-ins'.

However, over time, enterprise clusters may mutate from one type to another. In search for a dynamic theory of enterprise clusters, could we interpret these types as different stages of a possibly continuous evolution? This would be especially interesting insofar as the latter forms of clusters may exhibit greater propensities for diversification into new production lines through more complex networks and inter-firm linkages, rather than for upgrading along the present sectoral specialisation.

Some possible transitions through different types of clusters are illustrated in Fig. 2. Thus, instances of a transition from a Marshallian ID to a hub-and-spoke, with the emergence of larger oligopolistic companies (1), are provided by Detroit (automotive industry) and Pittsburgh (steel industry), respectively, in the first decades of the 20th century and at the end of the 19th century (Markusen, 1996a, p. 301). In principle, the same process might occur through the incubation of a hub within the ID, or in the event a state-anchored ID turned into a hub-and-spoke, with a private company replacing the public firm/institution (like e.g. in Colorado Springs; Markusen, 1996a, p. 308).

Similarly, satellite platforms may transform into a Marshallian ID by strengthening and intensifying backward and forward linkages among SMEs, both suppliers of intermediate goods and competitors for the same final markets (3). In the event that larger firms prevailed, or SMEs, as a result of increased competition or economies of scale (and of organisation), grew bigger and established leader–follower or hub-and-spoke links, then a hub-and-spoke district might prevail (4).

Among the three modes of clustering, the enterprise network requires, as well as offers, the largest opportunities to reach out much further, breaking geographical borders without losing its identity and preserving its specificity and uniqueness. This feature may prove remarkably useful when technological paradigms change, like in recent years, with the co-evolution of technology, industrial structures and the internationalisation of economic activities. This is explored in the following section.

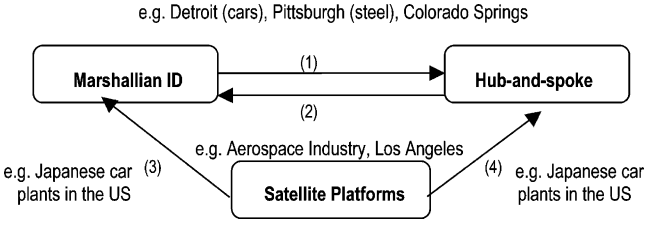

Fig. 2. Possible transitions through types of enterprise clusters.

3. The link between cluster evolution and technological regimes

Two new major features of the social and economic systems are emerging and have characterised the last two decades. On the one hand, technology increasingly plays a central role in all economic activities and the pace of technological change is becoming more and more rapid. On the other hand, the scope of all economic and enterprise activities has become global (Archibugi and Michie, 1998; Pietrobelli and Samper, 1997). These two dominant features are intrinsically inter-related and mutually reinforcing. Thus, the rapid pace of technological change brought about by improvements in communication and information technologies (ICTs) is facilitating the international expansion of economic activities, whilst this process of internationalisation is enhancing and further accelerating the pace of technological changes.

It has been widely shown that technology has become a crucial input, with the knowledge intensity of production growing remarkably. Consistently, since the late 1970s, intangible investments, including R&D, training, software development, design and engineering, have been growing at three times the rate of tangible investments (OECD, 1992). New technologies such as ICTs, biotechnology and new materials are creating new products (United Nations, 1995) while at the same time changing the characteristics and performance of many traditional products (UNCTAD, 1995).

The second dominant feature of the prevailing techno-economic model is the widespread internationalisation of all economic and technological activities. International trade and investments now account for larger proportions of national income in all countries. With the expansion of international trade and investments, technology is becoming more global as well. The nature of technology makes it more convenient for a company to extend its technological activities by sourcing technology abroad and striking R&D and technology partnerships with other companies and institutions (Pietrobelli, 1996; Cantwell and Iammarino, 2001). This knowledge needs to be sourced from different origins, as firms become less capable of supplying all the technological knowledge required, and inter-firm and inter-institution linkages acquire more importance for science and technology (S&T) and R&D.

The literature in this area has often studied the relationships between the technology in use and the pattern of technological change. An interesting approach to the analysis of the different patterns of innovation is centred on the notion of *technological regimes*. This concept was first introduced by Nelson and Winter (1982), and later developed by others (Malerba and Orsenigo, 1995, 1996a). Within this framework, a firm's rate of innovation is influenced by the technological (and industrial) environment facing the firm, that is, by:

- *Opportunity conditions*: the firm's likelihood to innovate, given the investment in research;
- *Appropriability conditions*: the possibility of protecting innovations, and the profits derived thereby from imitation;
- *Degree of cumulativeness*: the extent to which the amount of innovations produced in previous periods raises the probability of innovating in the present period;
- *Knowledge base*: the type of knowledge upon which the firm's activities are based.

In this framework, two polar models of innovative activities have been developed following Schumpeter, 1934, 1942). The first pattern of innovative activities has been called the *Schumpeter Mark I model*. It is characterised by conditions of medium–low opportunity, low appropriability and low cumulativeness. Typical features of this pattern are technological ease of entry in an industry, a relatively large number of innovators, a major role played by new firms in innovative activities which are continuously breaking through the current way of production, organisation and distribution. The second pattern of innovative activities, known as the *Schumpeter Mark II model*, is characterised by conditions of high opportunity, appropriability and cumulativeness, which are more likely to lead to a low number of innovators and the dominance of a few firms that are continuously innovating through the accumulation over time of technological and innovative capabilities. They employ their accumulated stock of knowledge, thereby creating barriers to entry in an industry for new entrepreneurs and small firms. Importantly, it has been shown that technological regimes are technology-specific (Malerba and Orsenigo, 1996b), that is to say that the pattern of innovations in one sector is very similar throughout every country.[13]

Does the technological regime within which firms operate have consequences upon enterprise clusters, and especially on their internal organisation, geographical location and innovative behaviour?

It is reasonable to expect that innovators will emerge from the location where technological opportunity is available and accessible (Baptista and Swann, 1998).[14] When there are conditions of high opportunity, high appropriability and high cumulativeness, as in the Mark II Model, innovators are geographically concentrated. This is also related to the firm's knowledge base, since the more technological knowledge is tacit, complex and systemic, the more constant inter-firm interaction will be needed; so one can expect a greater concentration of innovators, as this type of knowledge can only be learned through daily use, and requires informal personal contacts and exchanges (Nelson and Winter, 1982; Lundvall, 1988). This is what typically happens in a localised cluster and brings about greater industrial and geographical concentration. Conversely, geographical concentration should be less important when the industry's knowledge base is simple and well codified and conditions of low opportunity, low appropriability and low firm cumulativeness prevail. Here, a high degree of geographical dispersion of innovators is likely to emerge (Schumpeter Mark I). Are these hypotheses expected to hold in the present context?

The prevailing techno-economic model, with the diffusion of the ICTs and the rapid internationalisation of all economic and technological activities, would seem to lead toward an increasing relevance of Schumpeterian dynamics of the first type. Resources, capital and other inputs can be efficiently sourced in global markets. Furthermore, information and technologies become generic, increasingly codifiable, and are readily available via globalisation.

Thus, changes in technology and global competition have diminished some of the traditional roles of geographical location. Firms find it increasingly necessary to create knowledge through linkages with distant firms and organisations. The analysis needs to move beyond the boundaries of a region or nation state, and international knowledge linkages acquire increasing importance (Ernst, 2001).

But all this is only one side of the coin. In fact, location remains fundamental to competition, albeit in different ways, in the new techno-economic model dominated by ICTs (Cox, 1997; Storper and Salais, 1997). The relevant knowledge base involves tacit as well as increasingly codifiable and codified aspects. The former are related to a firm's specialised capabilities, while the latter refer to technological knowledge which is new, widely applicable and generic. So, if technology can be licensed or sourced from other locations, and components and equipment can be outsourced, other more complex dimensions of competitiveness remain geographically bounded and related to the Schumpeter Mark II model. The enduring technological and competitive advantages in a global economy are often still significantly local.

In this perspective, the spread of global production networks (GPNs) may be understood as an organisational innovation which may enable a firm to gain quick access to higher-quality and/or lower-cost foreign capabilities and knowledge, without losing the complementary locally clustered capabilities (Ernst, 2001).

To our present aims, these recent patterns impose drastic reorganisation demands on all enterprises. Such

[13] However, systematic differences in patterns of technological change across countries in all sectors have also been observed (Guerrieri and Tylecote, 1997).

[14] Baptista and Swann (1998) study the link between firms clustering and their probability to innovate, and find evidence of a positive relationship for the electronics sector.

changes are sweeping and imply comprehensive industrial restructuring, new skills and intermediate inputs. In their absence, competitive advantage may shift to another enterprise, group of firms or location.

From the above analysis, two working hypotheses may be singled out:

1. A shift in the technological paradigm that applies across sectors and that requires a substantial industrial reorganisation is being observed world-wide. Again, firms traditionally operating within a cluster or a district would need to learn to source their technological knowledge from the most advanced locations outside it, and to reorganise their knowledge linkages from a cluster-based approach to a wider and global approach such as the GPN model.
2. The prevailing form of the 'Marshallian' ID may not be the most adequate for the new technological areas promising faster and more sustained demand in world markets. In other words, the internal organisation of the Italian IDs, and their strength based on local interactions within the cluster, used to be essential in explaining their past performance in traditional sectors. Yet, this kind of organisation may prove less capable of tackling the challenges posed by a new technological regime and an environment that demands the internationalisation of production and commercialisation, and most notably of knowledge creation.

The comparative evidence on Italy and Taiwan presented in the following sections sheds some light on this issue.

4. Some evidence from Italian IDs in the textile and clothing industry

The textile and clothing industry has traditionally played a central role in the Italian pattern of specialisation since the Second World War. In addition, this sector is the most representative of *local systems* in Italy.[15] Looking at the country's export pattern, the textiles sector reveals the highest degree of geographical concentration, with only seven systems (10 provinces) accounting for the bulk of the industry's exports. Clothing exports are slightly more geographically dispersed, with 15 systems and 23 provinces contributing to 83% of Italian exports in 1995 (Conti and Menghinello, 1996). Moreover, this industry shows also a remarkable degree of internationalisation, with an average export propensity rising from 24.4% during 1987–1989 to over 33% during 1995–1997 (above that of total manufacturing, 31%). Similar remarks hold for inward and outward foreign direct investment flows, confirming the trend towards delocalisation of stages of production particularly towards Central and Eastern Europe and China (Table 1).

During their first stage of restructuring, which started during the 1980s, the Italian textile and clothing IDs have shown a greater capacity of reaction and adaptation to the new market conditions than the average SME (Guerrieri and Iammarino, 2001, pp. 39–42). This has had the following main characteristics:

- *personalisation of products*, that is, increasing and faster horizontal and vertical product differentiation, leading from price competition to quality competition;
- *greater flexibility* in the management of differences, both internal and external to the firm, with attention shifting towards formal and informal networks;
- acquisition of technological advantages, stemming from the diffusion of micro-electronics and from *industrial machinery and equipment*, which have allowed a higher degree of automation of production processes (Santarelli et al., 1991);
- some diversification processes mainly occurring through the specialisation, within the ID, in complementary sectors, such as machinery and equipment for textiles and clothing. Thus, the technological level of the latter products increased strikingly during the 1980s mainly because of the exploitation of embodied technology;
- the rise of *groups of firms* referring to a leader (occasionally a multinational) particularly in mature IDs—such as Prato, Como, Carpi—leading to more formal and long-term subcontracting linkages, once essentially founded on occasional and short-term contractual relationships;
- a much less pronounced hierarchization of inter-firm relationships in 'younger' districts specialising in textiles and clothing (e.g. in Teramo, Pesaro and Isernia), with many small firms repositioning their sales in

Table 1
Contribution of Italian local systems to national exports of textiles and clothing, 1986–1995

Sector	Number of local systems	Number of provinces	Percentage of share of Italian exports	
			1986	1995
Textiles	7	10	77.0	84.5
Knitwear	10	15	73.5	79.8
Clothing	15	23	68.1	83.1

Source: adapted from Viesti (1997), Table 3.

[15] Italy has almost 200 local systems of SMEs, of which nearly half can be strictly defined as IDs, while the others are either IDs in the birth phase, or remains of declined IDs, or polarised industrial areas. However, in the sector analysed here, the majority of local systems correspond to real IDs (Becattini, 1987).

small market niches, thanks to some degree of protection.

In sum, since the 1980s, most IDs have undergone changes in production structure to face international markets. This has occurred mainly by losing many upstream phases through relocation outside, very often abroad, and increasing their specialisation in downstream stages of production, characterised by higher value added (Carminucci and Casucci, 1997). On average, Italian IDs have shown a stronger propensity to upgrade their production rather than to diversify their sectoral specialisation.

However, in light of the newly prevailing conditions of international competition whose main features have been described in the previous section (i.e. internationalisation of markets, multinationalisation of production, globalisation of technological innovation, and changing technological regimes), are such strategies proving sufficient to stay ahead?

To this aim, it is essential to understand whether the balance between collaboration and competition within the district, along with the structure and the degree of openness of local networks, can generate reactions to external major changes, thus securing successful transformations.

In order to assess whether a renewal of competitiveness has occurred in Italian IDs, a fieldwork analysis was carried out in selected districts (Guerrieri et al., 2001). In particular, this study aimed at providing preliminary answers to the questions outlined above, and sketch the possible paths followed by IDs to cope with the increasing global competition and its new characteristics.

As is well known, the geographical identification of industrial districts is not straightforward, as the levels of the province and the commune usually overlap and none of them turns out to be the most appropriate to describe a specific local system. In fact, the Italian ID is often an intermediate area between the commune and the province. Therefore, the identification of industrial districts to carry out the direct survey had to hinge on several secondary sources (recent literature, surveys and empirical analyses on IDs).

Notwithstanding the limitations, the choice of the province as the unit of analysis seems to represent a good approximation of geographical agglomerations such as IDs. Thus, the structural characters of production and export specialisation of Italian provinces and, more importantly, their dynamics in terms of performance during the 1980s and the 1990s allowed us to single out some possible geographical differences in the restructuring of competitiveness of local systems of textile and clothing production.[16] Among them, three case studies were selected to be studied in greater depth, taking into account criteria such as the identification of the 'dominant' industry in the specialisation pattern of the district, the variety of historical backgrounds, the search for older and younger districts, the variety of structural features and performance, and the features of the export performance also of the related sectors of machinery and equipment for textiles and clothing.

In spite of the caveat implied by this exercise, Prato and Carpi were chosen as representative of 'older' districts, whilst Teramo was selected as an example of a 'younger' ID. The field work was carried out in the summer and autumn of 1998 on the basis of EU-harmonised questionnaires administered to a random sample of textile and clothing SMEs, with interviews to 48 SMEs overall.

Firms on average turned out to be older in Prato and Carpi, and younger (late 1970s) in the newer district of Teramo. Surveyed firms are also larger in the latter district, with seven firms between 21 and 40 employees and four employing more than 40. Recent performance, as measured in terms of sales, has been better in Prato, with an improving trend over time, relative to an almost stable pattern in Teramo and a sudden decline in Carpi in 1997, after years of increasing sales. Enterprises in Prato and Carpi appear more export-oriented, with, respectively, 54% and 33% of total sales going to foreign markets, than in Teramo, where exports account for only 17% of sales. Most of these exports go to EU markets (54.2%).

Furthermore, data on the share of output sold to the top three customers in 1997 show that Prato and Carpi exhibit rather low percentages, 31% and 22%, respectively, while Teramo's firms seem to rely much more on top customers, with an average share of output sold to the main three clients equal to 63%. This may suggest a stronger concentration of subcontracting relationships in Teramo than in the other two more mature districts, and is confirmed by qualitative evidence.[17]

One central target of the survey was to assess and measure the 'cluster effect'—that is, the extent to which the location in the ID is perceived as important (strategic) by the firm—its relative openness, and its impact on enterprise performance. The main results may be described as follows:

[16] The analysis of textile and clothing exports was carried out at a detailed level of sectoral breakdown (i.e. 27 groups of products for textiles and 15 for clothing, numbered from 99 to 140 according to the Istat classification, which includes 236 product groups, with reference to the province unit). In spite of the presence of more than one local system in the same province, by considering detailed classes of products, it was possible to obtain a rather accurate picture of the contribution of the 'dominant industry' given by geographical systems to national exports.

[17] The results of this survey can by no means be generalised. However, this result is confirmed by the recent survey on Italian IDs carried out by the Bank of Italy (Pizzi, 1998).

- The background of the entrepreneur/founder is often a family business (46% of all firms) or another SMEs (33%), both located in the same cluster. This confirms the traditional result on the importance of family ties, traditions, and a sort of 'path-dependence' in Italian districts.
- Product innovation, both as *new to the firm* or *new to the sector*, has been scarce (limited). However, exactly 50% of all surveyed firms undertook improvements in existing production processes, mainly consisting of the use of new specialised machinery, equipment and computer-assisted technologies. This confirms once more the central role played by a related sector, such as machinery and equipment, in innovation in SMEs in traditional productions.[18]
- Turning to the *external sources of technology*, customers and equipment suppliers were judged as crucial by our respondents: indeed, in both cases, 25 respondents attributed a high score to it. Considering the main external source of technology by its geographical origin, in Prato local together with national and international customers were ranked as the leading channel of technological sourcing. Only in the case of Teramo did no international linkages turn out to be important.
- Local and national equipment suppliers emerge as the main external source of technology in all cases, strengthening the hypothesis on the interplay between the collective creative capacity and more formal R&D activities (Bellandi, 1996).
- The geographical features of relevant linkages are especially noteworthy in our sample. In Prato, local technological linkages are rather strong (with 10 firms indicating the local environment as the origin of the main source of technology), as well as for Teramo (with nine firms), but while in Prato and Carpi firms also show a relatively international openness, the respondents in Teramo do not have any major technological channel with sources outside the country. This would support the idea of a relative closeness of Teramo with respect to the 'older' districts.
- Overall, our data would suggest that the intensity of local linkages, and therefore the strength of an 'ID atmosphere', is far more perceived in the two 'older' districts of Prato and Carpi than by respondent firms located in the 'younger' ID of Teramo, which attached a lower rating to local connections as a whole. Moreover, linkages with service providers were deemed important in Prato, and linkages with private financial institutions in Carpi.

[18] As expected, R&D is not at all the principal source of innovation for SMEs operating in traditional sectors. Indeed, the expenditure on design, development and engineering amounted to very small values in all districts. Overall, 13 firms out of 48 declared that they performed 'some' R&D.

The well established system of networking detected in Carpi and Prato by this and many other studies may not only encourage interdependence and collective learning but also facilitate future integration in global networks and the response to the challenge of the ICT revolution.[19] On the other hand, the relative lack of internationalisation and perception as being part of a local system detected in Teramo may turn out to be a critical drawback in the complex path to stay ahead in global markets.

How can we summarise the evidence gathered from this survey on three prominent Italian IDs, in light of the theoretical hypotheses on the evolution of technology regimes, and the implications for cluster organisation?

- The evidence presented confirms the importance of the *industrial atmosphere* and the strength of the Marshallian model in traditional IDs like Prato and Carpi. This appears to occur to a lesser extent in younger IDs, such as Teramo.
- Proximity matters and will continue to matter. However, this needs to go together with an attitude of industrial districts to open and reach out distant markets and partners, and become part of international integrated system.
- However, the limited knowledge of new global technological languages, as well as the lack of substantial organisational changes required by the new technologies to be effective, may progressively cut out geographical clusters and, as a result, 'industrial atmosphere' might not be sufficient any more to stay ahead in the global economy.

Sectoral trends are showing univocal signs towards radical organisational changes, with the clothing industry facing even bigger risks than textiles, related to the rising dominance of much retail trade by large firms and multinationals, and the ensuing substantial change in marketing and distribution activities.

Indeed, the global challenge implies not only relocation of production in search of low labour costs, but even more a variety of industrial organisation. Most firms, both small and large, are learning to acknowledge the crucial importance of participating in global inno-

[19] It has been pointed out, with reference to the Italian cotton industry, that the adoption of ICTs may display its economic effects in terms of overall productivity levels "…only when associated with systematic changes in the organisation based upon systemic networking among different firms and different units within the firms". Furthermore, the efficiency brought about by the adoption of ICTs can be effective only with the introduction of "… parallel changes in [firms'] organisation in terms of closer interaction among internal functions such as production, marketing, finance and strategic decision-making, higher levels of vertical integration and product diversification, closer interaction with customers and providers of intermediate goods and services" (Antonelli and Marchionatti, 1998, p. 13).

vation networks which entail relationships with suppliers, distributors, financial systems and customers, each of them contributing differently to the innovation of products and processes, and boosting the productivity and creativity of everyone in the network. So far, in the Italian IDs specialising in traditional sectors, the exploitation of the potential offered by global networks to strengthen communication and information has been rather weak. This differs remarkably from what is occurring in other emerging parts of the world, as the evidence on Taiwan, presented in the next section, suggests.

5. Clusters and networks in Taiwan's electronics industry

The comparison between selected cases of industrial clusters in Italy and Taiwan may appear hazardous, but this is only apparent at first sight. In reality, in both economies, SMEs represent the bulk of industrial structures. Furthermore, both countries are fully integrated into the current processes of internationalisation and globalisation. Taiwan has been one of the earliest developing countries to open up to international economic flows, first targeting export markets, and then relying on the direct investments of foreign multinationals. More recently, Taiwanese companies have also started to invest overseas and to strike strategic linkages with transnational corporations.

What makes the comparison especially instructive as well is the countries' different patterns of industrial specialisation. Italy has been, and still is, mainly specialising in 'traditional' products such as furniture, textiles and clothing, ceramics, and industrial machinery, sometimes the heritage of craftsmen's skills and capabilities, and often localised in industrial districts. The pattern of Italian foreign trade has hardly changed over time. In contrast, Taiwan, after an early phase of specialisation in labour-intensive clothing, has experienced a remarkable structural transformation and rapid diversification towards electronics and electrical machinery since the 1980s.

During the 1990s, Taiwan achieved great success in the electronics industry, and especially in the information technology (IT) area. In 1998, the value of domestic and foreign production of the Taiwanese IT industry was over US$ 30 billion and ranked third in the world for the production of computers, following the US and Japan. In terms of export value, Taiwan's electronics industry has overcome textiles and clothing—traditionally the core industry of the Taiwanese specialisation model—to become the leading exporting sector since 1994.[20] This outstanding success is all the more surprising for an economy with scarce resource endowments and dominated by SMEs.

This remarkable restructuring has occurred during the last two decades in reaction to an increasing competitive pressure. The sharp appreciation of the new Taiwan dollar, the severe shortage of labour and the consequent escalation of wages, the loss of the Generalized System of Preference (GSP) status, the rise of real estate prices and the aggressive competition from the Korean *Chaebol* in the late 1980s were all factors that have tremendously affected SMEs operating in traditional labour-intensive industries. Many of them were thus compelled to shift production abroad (mainly to South-East Asia and mainland China) to maintain competitiveness. The remaining enterprises had to redirect their business towards more skill-intensive, R&D-oriented products, searching for new product niches and new market areas to survive.

Indeed, the textile and clothing sector has undergone a strong process of upgrading from a few traditional spinning and weaving products to capital and technology intensive man-made fibres and fashionable clothing. Currently, garment firms which continue to produce in Taiwan are all specialised in high-end products with strong design content. At the same time, the overall industrial structure has diversified remarkably towards higher-technology products and sectors.

The electronics industry in Taiwan has followed a totally different path of development. While the textile and clothing industry received little foreign direct investment, the electrical and electronics industry depended heavily on international markets and access to foreign technology from the international sector. Furthermore, the rapid expansion of the information industry provided a lot of new opportunities for both existing and new SMEs.

At the end of the 1990s, substantial structural adjustments occurred in the electronics industry, particularly in the computer sector, spurred by structural imbalances, high volatility of original equipment manufacturing (OEM) orders and an increasingly competitive environment.

There has been an intense debate on how Taiwanese firms, most of them SMEs, have been able to compete successfully in the international market. Abundant human capital, strong information networks among local and overseas Chinese engineers, flexible and specialised production systems and broadly based supporting industries are all commonly mentioned as distinctive characteristics of Taiwanese SMEs (Kuo, 1998). An important distinctive feature of the Taiwanese supporting network is that it never implied a stable relationship between input suppliers and users, which instead characterises the

[20] Machinery, electrical and electronic equipment accounted for 22% of Taiwan's total exports in 1981, and 50% in 1998 (with information and communication products—the highest technology sub-set—growing from 0.7% to 12.4% of total exports during the same period).

Japanese case. Probably due to the dominance of small size and to the unstable competitive environment, the "centre" firms exerted a constant pressure to squeeze input suppliers and bargained hard to reduce costs. This has propelled the improvement of SMEs, although clearly not all of them could succeed (e.g. see Kuo and Wang, 2001, p. 71).

The same methodology and survey questionnaire employed in Italy was also utilised for the Taiwanese field study to gather microeconomic evidence on the restructuring efforts and the sources of competitiveness of selected electronics SMEs. Enterprises were interviewed in the summer–fall of 1999, in the textile and clothing and in the electronics sectors. All 23 SMEs surveyed in electronics were located in northern Taiwan, reflecting cluster effects in Hsinchu County and in Taoyuan County.

The evidence collected is presented in greater detail by Kuo and Wang (2001), and reveals remarkable differences from the Italian cases. Thus, for example many company founders (12 out of 23) had previously worked in large domestic or multinational companies, already suggesting an intense interaction between these groups of actors.

Moreover, the interviews carried out support the view that OEM/ODM orders have helped manufacturers acquire technological and product design capability from foreign companies, at the same time absorbing relevant experience in product management and shipping procedures. This valuable feedback effect has greatly enhanced the learning and innovative capacity of SMEs in Taiwan (Ernst, 2001). At the same time, a high percentage of the equipment used by SMEs is purchased abroad, with crucial elements of technical know-how embodied in this equipment.

Most of these firms were also helped substantially by the numerous government policies to support SMEs in the electronics sector, whose role cannot be understated. These policies range from joint private and government R&D (e.g. the 'Alliance for the Joint Development of Notebook Computers'), to subsidies for the development of leading new products (with 50% of the development costs covered by government subsidies), active venture capital funds, S&T Parks modelled on succesful foreign experiences such as Silicon Valley (e.g. the notable example of Hsinchu Science-based Industrial Park (Saxenian and Hsu, 2001, Lee and Yang, 2000), to several government-sponsored research institutes for the generation and transfer of advanced technology (see Kuo and Wang, 2001; Kuo, 1998; Gee, 1995, for details). Moreover, a central area has been in the domain of building a remarkable array of inter-firm and inter-institutional linkages, often promoted by government policies.

A key explanation of the success of SMEs competing in globalised high-tech industries, supported by our survey evidence, is the *co-evolution of domestic and international knowledge linkages*. In other words, inter-firm and inter-institution linkages have been built to provide local SMEs with the necessary externalities to cope with the dual challenge of knowledge creation and internationalisation. Let us see how these linkages have developed for Taiwanese SMEs.

When Taiwan began to enter the computer industry during the late 1970s, domestic linkages did not exist. International linkages were thus of primary importance from the outset, together with the gradual development of domestic linkages. Two main types of international linkages prevailed: inward FDI, which played an important catalytic role in knowledge creation during the early phase, and the participation of Taiwanese firms in GPN established by foreign electronics companies. The latter has represented a remarkable organisational innovation, and its main features have been aptly described by Ernst (2001) and summarised in Table 2.

Taiwanese SMEs, as well as the government, have pursued a *plurality* of approaches in parallel to build a variety of *domestic linkages*. Among these forms of linkage creation, the following have been considered especially important (Ernst, 2001, pp. 101–107):

- Informal 'peer group' networks, whose focus has shifted from labour, capital and basic market information to technological knowledge and brand name recognition. Originally, these networks were restricted to family and kinship relations. Now they have evolved to professional 'peer group' networks, which are especially required in electronics and high-tech industries.
- Hierarchical centre–satellite systems to encourage closer, interdependent and long-term ties between larger 'centre' firms (upstream suppliers, final assemblers, large trading companies) and their 'satellites' (especially component suppliers). These links have often been favoured and subsidised through government policies.
- Linkages with large domestic firms, often in the form of cross-sectoral business groups. The shift to business groups has been most pronounced in the electronics industry, due to the critical importance of economies of scale and scope, the necessary linkages with foreign customers through international subcontracting and OEM arrangements, and with international supply sources, especially for key components.
- Business groups centred around a holding company, and creating a federation of loosely connected companies united by four factors: access to common core technologies; access to the holding company's financial resources; access to its knowledge base, market

Table 2
Features of different forms of clusters and models of industrial organisation

Features	Marshallian ID (ITA = Italian variant)	Hub-and-spoke district	Satellite industrial platform	State-anchored industrial district	Global production network (GPN)
Prevailing market structure	Local SMEs	One/several large firms and suppliers	Large firms external to the district	One/several government institutions providing infrastructures	Global oligopolies with networks of local SMEs
Extent of geographical agglomeration	High	Fair	Limited, extended beyond local cluster	High	Limited, extended beyond local cluster
Economies of scale	Low	High	High	High	Highest (also for SMEs, often part of several GPNs)
Intra-district trade	Highly developed	Between large enterprise and suppliers	Minimal	High between institution and suppliers	Limited
Key investment decisions	Local decision	Local decision, but globally dispersed	External decision	In local government or external to the ID	Foreign contractor
Regulation of relationships	Long-term contracts	Long-term contracts	Short-term contracts	Short-term contracts	Contracts subject to instability
Co-operation with firms outside the ID	Low	High	High with parent company	High with parent company (institution)	High with foreign contractor company
Labour market	Internal to the district, highly flexible	Internal to the district, flexible	External to the district, internal to the large enterprise	Internal (government), national from other institutions	Global (for high skills)/local
Main workers' commitment	With the ID	With large firm	With large firm	With government institution, then with ID	With local SMEs
Local cultural identity	Developed	Developed	Virtually absent	Developed	Developed locally, not across the GPN
Sources of knowledge and innovation	Internal to the ID	Mainly in the hub	Mainly in parent company	Local institution	Global
Sources of financing and technical assistance	Internal to the ID	Large firm	External	External (national/local government, military base, state university or research centre)	Foreign contractor improves local firms' access to finance
Patient capital[a]	Exists	Scarce out of the large firm	Non-existent	Non-existent	
Local trade associations	Strong presence (ITA)	Virtually absent	Absent	Weak	Yes
Role of local government	Important (ITA)	Important	Important	Weak in regulation and industry promotion/important in infrastructure	Useful in promoting local participation to global networks

Source: own elaboration inspired by Markusen (1996a, b), Castellano (1999), Ernst (2001).

[a] Presence of financial institutions willing to take long-term risks, for the confidence and information they possess.

intelligence and technology scanning capabilities; and a common brand name.[21]

Thus, contrary to conventional wisdom, *large firms* have played a central role in the co-ordination and development of the Taiwanese computer industry, and have also acted as *important sources for knowledge creation in SMEs*.

Moving to international linkages, these not only encompass critical imports of key components and capital equipment, but also crucially facilitate local capability formation. A GPN may be taken as a paradigmatic example to describe the strategic complementarity of linkages with foreign networks of firms and institutions and localised external economies. The logistic complexity of a GPN is not simply a result of its geographic spread, but also a function of an increasingly complex division of labour. In fact, each GPN combines different hierarchically structured and closely interacting sub-networks.

Taiwanese firms in the electronics industry are deeply embedded in complex global production networks that involve transactions between a large number of different national production systems. What factors have induced large computer companies to increase their reliance on outsourcing and hence to establish GPNs and local SMEs to participate in them?

From the point of view of a large global competitor, concentrating on product development while at the same time remaining a low-cost producer to stay competitive in international markets is vital.[22] Thus, large multinational firms tend to focus on R&D and on the production of some key components, and outsource most of the other activities, forcing potential suppliers to compete and reduce production costs.

From the point of view of small suppliers from a small country like Taiwan, participating in a GPN can provide various advantages, such as:

- Manufacturing on an OEM basis is a significant source of knowledge creation for affiliated firms. Knowledge is transmitted through the supply of blueprints, the interaction of personnel and the transfer of tacit dimensions of technology.
- A supplier may then use the relevant technology and technical expertise acquired in manufacturing on an OEM basis for other multinationals. Thus, Taiwanese firms often participate in more than one GPN.
- This process allows local SMEs to achieve economies of scale, and in turn justifies the installation of capital equipment that is otherwise too large and costly.
- Letters of credit by the foreign purchaser allow local suppliers to borrow additional capital.
- Participation in a production network saves the expense of building distribution, sales and service networks. This reduces the costs of acquiring knowledge about foreign consumer preferences, and of setting up the distribution and service networks, a formidable challenge even for large multinationals.

Although, in principle, marketing products under the firm's own brand name (OBM) may allow higher profit margins, many Taiwanese companies have found that the costs incurred in setting up distribution, sales and service networks can outweigh their benefits. In several instances, OEM relationships and GPNs have moved rapidly beyond production to encompass an increasing variety of knowledge-intensive, high-end support services (Ernst, 2000).

In sum, inter-organisational knowledge creation is critical for small firms that compete in high-tech industries such as the computer industry, in years of changing technological regimes. If well organised and managed, such external knowledge linkages can effectively compensate for some of the original size-related disadvantages of small firms. Such a model of industrial organisation has produced the *co-evolution of domestic and international knowledge linkages*, remarkably favouring the competitiveness of Taiwanese SMEs.

6. Conclusions

The selected evidence discussed in the paper suggests three inter-related propositions. First, there is no one best model for organising an industrial district or an industrial cluster, since a diversity of institutional arrangements is possible and each has proved successful in different circumstances. Second, clusters are not cast in iron, but evolve over time. Third, globalisation reshapes the upgrading options for SME-based clusters, by providing a variety of international knowledge linkages. In a nutshell, globalisation changes both the concept of proximity and the scope of competition: a necessary prerequisite for competitive survival is the capacity to foster the co-evolution of local and global linkages and networks, and to develop new interactive modes of knowledge creation.

The first two propositions are fully confirmed by the reorganisation of both the Italian industrial districts and Taiwanese SME-based clusters, particularly over the past decade, as analysed in the paper. Industry- and firm-specific differences provide one possible explanation for the diversity of cluster development trajectories. However, the industry-level explanation is not sufficient by

[21] This has been named the 'client–server' model.

[22] The cost of components, software and services purchased from outside has increased to more than 80% of total (ex factory) production costs (Ernst and O'Connor, 1992), thereby raising co-ordination costs substantially. As a result, the *reduction of the cost of external sourcing* through rationalisation and internationalisation represents a central strategic concern.

itself, and some new features of the technological regimes challenge all industries, though in different ways. The consequences of globalisation on industrial restructuring and reorganisation are going to be felt more and more across sectors in the future, and so the industry level could not be the relevant unit of analysis of such changes.

Geographical dispersion is occurring on a massive scale. However, geographic dispersion does not lead to the wonderland of a 'borderless world' (Ohmae, 1991), and the *gravitational forces of geography are not rescinded by globalisation.* A breathtaking speed of geographical dispersion has been combined with spatial concentration, and much of the recent cross-border extension of manufacturing and services has been concentrated on a handful of specialised local clusters. Thus, rapid cross-border dispersion coexists with agglomeration, and agglomeration economies continue to matter, as well as the path-dependent nature of cluster evolution. Moreover, dispersion is no longer restricted to lower-end activities, and notably applies also to more traditional sectors such as textiles and clothing (Ernst et al., 2001).

Systemic forms of integration are emerging *to combine geographic dispersion with localised concentration*. Global production networks represent a remarkable example of such evolution, and their concept may have some important implications for the future evolution of the Italian industrial districts as well. Systemic integration implies that international linkages are no longer secondary, quasi-optional to domestic linkages. Instead, existing clusters in any two countries supplement each other and may experience mutual inter-penetration. Under such conditions, international linkages are essential for the continuous growth of an industrial cluster.

This is self-evident for network suppliers, especially lower-tier ones, whose growth and strategic direction is heavily determined by the network or cluster leaders. But it has important implications also for the experience of the Marshallian industrial districts and the high locally concentrated innovation capability that has been characterising their evolution up to now. In fact, such international linkages can recharge local linkages. They provide important opportunities for international knowledge sourcing (a possible explanation for Silicon Valley's apparently inexhaustible upgrading capacity).[23]

In this perspective, we argue that the prevailing form of the 'Marshallian' ID may not be the most adequate for exploiting the new technological opportunities promising faster and more sustained demand in world markets. The preliminary evidence presented suggests that, in the 2000s, the organisation of economic activities in IDs will necessarily be post-Marshallian, that is, less locally confined and less vertically disintegrated.

The integration into the global economy, through international networks and markets, corporate hierarchies, global production and technological organisation, is boosting the importance of *functional integration* vis-à-vis *geographical integration*. The latter was one of the fundamental conditions for the emergence of IDs, and will continue to be an essential factor, provided that the necessary organisational changes connected with complex technologies are introduced.

The current shift in the technological regime that applies to all sectors and requires a substantial industrial reorganisation poses formidable challenges to the industrial organisation of SME clusters. New technologies, and particularly the ICT paradigm, have permitted the intimacy that used to be possible only within a cluster to take place over long distances. Firms traditionally operating within the ID mould need to learn to source their technological knowledge from the most convenient locations outside the ID, and to reorganise their knowledge linkages from a cluster-based approach to a global approach.

[23] The critical importance of international linkages is also reflected in the dense links between the Valley and Taiwan, India, and China, through trans-national technical communities, especially circuit designers and computer engineers, recently studied by Saxenian (1999).

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