Strategizing in industrial clusters and suprafirm structures

Collective efficiency, increasing returns and higher-order capabilities

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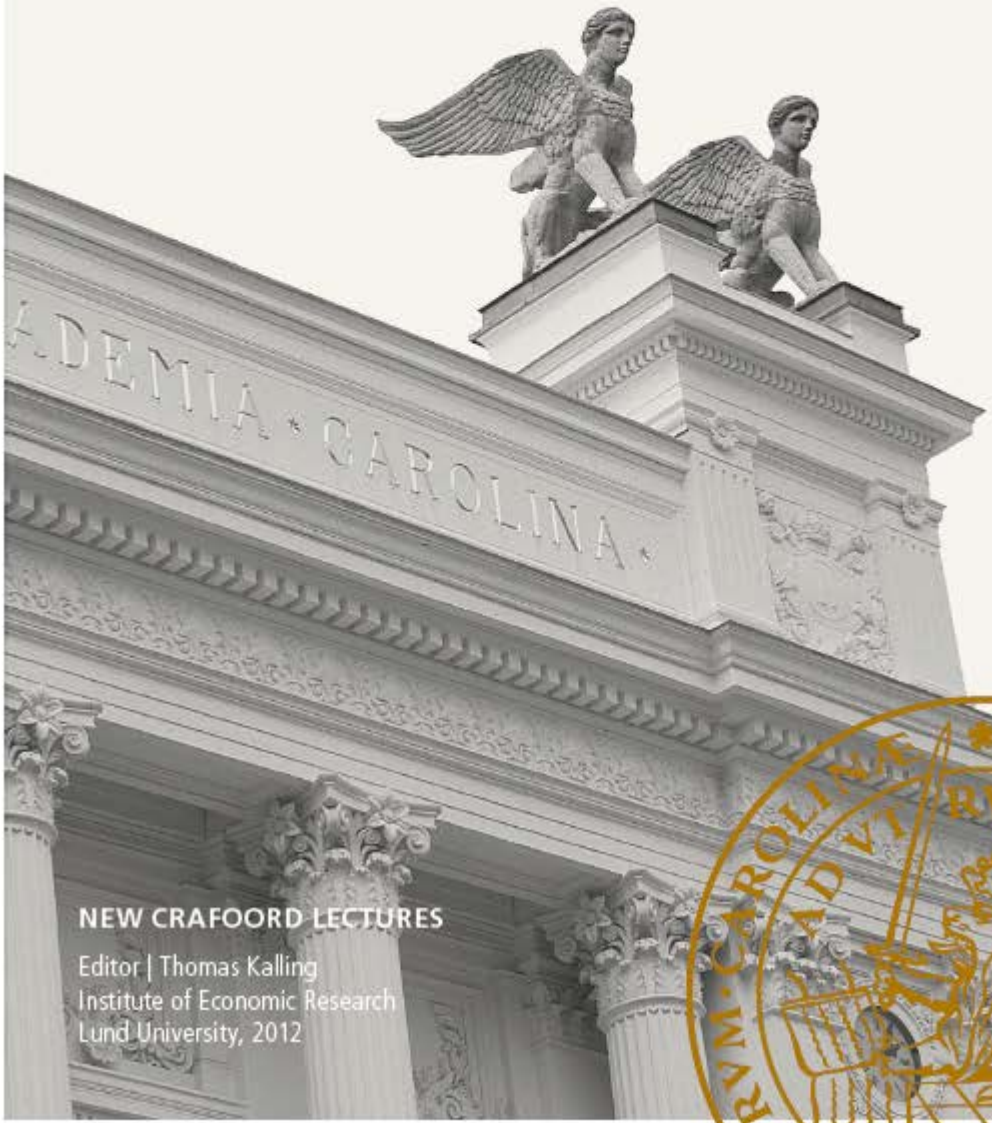

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Holger Crafoord 1908-1982

The Crafoord Memorial Lecturers were initiated at the Lund Institute of Economic Research at the School of Economics and Management in 1985, to honour the memory of *Holger Crafoord*, who, throughout his career as an entrepreneur and industrialist, supported the development of research and education institutions at Lund University and other places. This legacy is carried forward by the *Crafoordska Stiftelsen*, whose continued support includes the publishing of this volume.

Introduction

Thomas Kalling

Understanding how new business models and new companies come to life of course is and has been a central question for many academics over time. Understanding how new ventures come about and are nurtured to become successful businesses is at the centre of much research. Similarly, the field of strategy has become increasingly occupied with organizational renewal and internal entrepreneurship in recent years. It seems as if the days when strategy scholars were concerned primarily with costs, prices, and market positions are long gone. Today, strategists are increasingly focused on growth, innovation and the creation of new businesses—something that entrepreneurship researchers have been involved with for a long time. Strangely enough perhaps, the intersection of the strategy and entrepreneurship fields has not been researched extensively. This volume assumes that the merger of strategy and entrepreneurship theory may be a fruitful way to improve our understanding of the premises under which corporations come about and renew themselves.

For that purpose, we gathered some of the leading strategy researchers for the Crafoord Symposium in late 2010 in Lund, at the School of Economics and Management, to hear their views and to take part of their recent ideas on entrepreneurship. *Jay B. Barney* (Ohio State) has been one of the leading strategy researchers of the last two decades, being particularly renowned for his seminal pieces on the resource-based view. *Nicolai Juul*

Foss (Copenhagen Business School) has conducted major work on a broad range of strategy and entrepreneurship themes. *Peter G. Klein* (University of Missouri) has written extensively on, among other things, the economics of the firm, strategy, corporate governance and economic institutions. *John A. Mathews* (Guido Carli University and Macquarie University) has studied and written about strategy, entrepreneurship, industry development, and cluster creation, not least in Asia. They have all contributed to this volume with different perspectives on entrepreneurship.

Sharon Alvarez, *Jay Barney* and *Mitch Angle* focus on entrepreneurial opportunity and the differences between Discovery theory and Creation theory to explain differences in the entrepreneur's approach to new opportunity. Both theories assume opportunities arise as competitive imperfections arise. But whereas Discovery assumes that these imperfections come about exogenously, unrelated to entrepreneurial activity, Creation theory focuses on the role of the entrepreneur in creating opportunities, through individual processes, actions and decisions. As the authors argue, Creation theory rests on different philosophical underpinnings, in which the entrepreneur is seen as an active maker of opportunities. He or she "does not pick a hill in the landscape and climbs it; the entrepreneur in Creation theory builds a new hill that previously did not exist". Creating opportunities is an emergent and path-dependent process of trial and error, much like strategy processes or learning processes, in which negative feedback causes correction in behavior and new attempts. Processes can lead both to dead ends as well as to new opportunities not imagined or foreseen at the outset. Alvarez et al conclude, with illustrations, that Creation theory differs from Discovery theory in terms of decision-making, business planning and finance. And whereas the Discovery Entrepreneur makes decisions based on empirical data and extrapolation, takes actions based on a set business plan and seeks funding from external sources such as banks and venture capital firms, the Creation Entrepreneur trusts his/her biases and heuristics, has a flexible

business plan (if any), and typically raises funds closer to him/herself, for instance bootstrapping—primarily as the uncertainty is too big for any outsider to invest. Alvarez et al claim and demonstrate how we need both theories (and others too) in order to understand entrepreneurial strategies to seize opportunity. Opportunities may arise, but they can also be created.

Nicolai Foss addresses the weaknesses in the existing literature on strategic entrepreneurship, and uses theory on organizational design to prepare for a more profound understanding of entrepreneurship within established firms. Biases in the existing literature, such as the focus on the individual (entrepreneur), the focus on startups and, as is also emphasized by Alvarez et al, the focus on opportunity discovery, have led researchers astray from the question of corporate entrepreneurship. And one key feature, separating the startup from the established firm, is organizational design (control and structure) and the division of labor (e.g. the degree of specialization). Understanding these differences is fundamental to our ability to develop new theory about firm-level entrepreneurship. Foss exemplifies how firms can organize and work with the micro-foundations of firm-level entrepreneurship, including the division of labor, motivation-opportunity-ability (the MOA framework), discovery, evaluation and exploitation.

Peter Klein takes a broader perspective, and discusses the implications of entrepreneurship, strategy and organization for public policy. Based on Knight (1921), and in light of the focus in later years on corporate legitimacy, Klein uses a judgment-based approach to entrepreneurship to discuss atypical applications of entrepreneurship theory on three seemingly different fields of society: policies of economic stimuli, market regulation and public entrepreneurship. Klein applies the judgment framework to the financial crisis in 2008 and claims it is difficult to understand the crisis without recognizing the heterogeneity of entrepreneurs, resources and firms, and that policy reactions to downturns might fail if they do not reflect

this heterogeneity. As a second example, driving aggregate demand by stimuli also leads to the empowerment and strengthening of failing entrepreneurs. Similar situations can occur in the public domain. Klein discusses the premises under which the derived judgment approach can help us understand the work of civil servants, politicians, and bureaucrats. The governing mechanisms of the citizens-public actors relation must be designed with regards to both derived and original judgment, as the opportunities for private (and not just public) wealth generation through "public entrepreneurship" can be significant in the public arena. Here too, the judgment approach on entrepreneurship can be applied with relevance.

John Mathews's paper on clusters underlines the relations the firm has to its environment, and how these relations have flown under the radar within neoclassical economics—as well as in strategy and strategic management, at least until recently. Despite the significant success of industrial clusters in the US, Europe and Japan, and perhaps even more so in developing countries, very little scholarly work has been done on clusters. Mathews hypothesizes, however, that this will change, as the strong and entrepreneurial economies of the 21th century, like China and India, have grown and will continue to grow significantly thanks to the creation of clusters such as the Deng Xiaopingian Special Economic Zones (SEZ) in China. Mathews discusses the network paradigm and the premises under which firms strategize in such environments, focusing in particular on core firm attributes: activities, resources and routines. Subsequently, the evolutionary dynamics of industrial clusters is discussed in light of Marshall's earlier theories and with more recent developments within evolutionary theory and economic geography. Mathews recounts Marshall's analysis of the metal cluster that emerged around Sheffield in the 19th century, and how the shared pool of skilled labor, supplier links and knowledge spillovers helped drive what was perhaps the main source of entrepreneurship and growth for the entire British manufacturing sector. Today, however, Sheffield is one of the poorest areas of Europe, and Mathews also analyses its decline,

arguing that a narrowing set of skills, activities and products did in fact lead to a lock-in situation, including contracting, not expanding, networks within established sectors. In contrast, thriving networks such as those in Silicon Valley and Hsinchu, Taiwan, have been able to develop new relations with external, interdependent industries. Using Schumpeter as a reference, Mathews underlines how creative destruction and new developments are necessary prerequisites in order to understand how clusters develop and how they foster real entrepreneurship. The organizational dimension of clusters, i.e. the synergetic bundling of resources and the connection between firms, constitutes the strategizing options for firms. And these cluster features, Mathews argues, "are not the product of economic laws or deterministic processes, but the outcome of mutually conditioned entrepreneurial initiatives".

The fields of entrepreneurship and strategy will most likely continue to merge in the future. Both fields feed each other, which these four articles clearly demonstrate. Furthermore, they underline the multitude of settings in which the two fields can co-exist: on the level of the entrepreneur, the firm, the regional cluster, the industry, and on the societal/public level. And in a world of increasing competition, globalization, technological development and enforced demands on corporate conduct, it is not difficult to foresee a future where the fields of strategy and entrepreneurship mix to develop new frameworks and understandings of the processes underlying organizational and societal wealth creation.

Strategizing in industrial clusters and suprafirm structures:

Collective efficiency, increasing returns and higher-order capabilities

John A. Mathews

Introduction

> No man is an island, entire of itself;
> every man is a piece of the continent, a part of the main. If a clod be washed away by the sea, Europe is the less,
> as well as if a promontory were,
> as well as if a manor of thy friend's or of thine own were.
> Any man's death diminishes me because I am involved in mankind; and therefore never send to know for whom the bell tolls;
> it tolls for thee. . . .
>
> John Donne, *Meditation* 17 (1624)

> When an industry has thus chosen a locality for itself, it is likely to stay there long: so great are the advantages which people following the same skilled trade get from near neighbourhood to one another. The mysteries of the trade become no mysteries; but are as it were in the air, and children learn many of them unconsciously. Good work is rightly appreciated, inventions and improvements in machinery, in processes and the general organization of the business have their merits promptly discussed: if one man starts a new idea, it is taken up by others and combined with suggestions of their own; and thus it becomes the source of ideas. And presently subsidiary trades grow up in the neighbourhood, supplying it with implements and materials, organizing its traffic, and in many ways conducing to the economy of its material.
>
> Alfred Marshall, *Principles of Economics*, IV, X, 7 (1890)

In the real economy, where businesses are constantly being born and striving to make connections with each other, it is a truism that "no business is an island" (Håkansson and Snehota 1989). It has also become a truism that firms that cluster together generate knowledge spillovers—the secrets of the trade being 'in the air'. It may be clearly evident that firms generate mutual advantages from clustering together; it may even be evident that firms acquire their identity through the relations they build with other firms (just like other social creatures) and that the more interfirm relations a firm builds, the broader its strategic options. Nevertheless this fact continues to be ignored in

neoclassical economics, which treats firms rigorously as atomistic entities, and until recently it was ignored in strategic management as well, where the firm was considered an independent and autonomous agent in terms of its strategizing. In this Crafoord paper, I should like to elaborate on these themes, expanding on the thoughts first canvassed in my 2006 book *Strategizing, Disequilibrium and Profit*.[14]

The reality of interfirm linkages and their creation of systemic benefits for the firms that participate in such suprafirm structures as clusters and networks, is not in doubt. Four anniversaries in recent times register this fact. The first celebrates thirty-plus years since the Florentine scholar Giacomo Becattini published his pathbreaking paper in 1979, an article perceptively titled 'From industrial 'sector' to industrial 'district'—laning that the mainstream practice of aggregating industrial statistics into sectors was missing the point that firms tended to cluster, in self-reinforcing and sustaining groups that Becattini characterized as Marshallian industrial districts, in ways that should be statistically evident if efforts were made to identify them. This article opened the gates to a stream of work on industrial districts and clusters that is getting stronger and stronger, and placed Marshall as the clear intellectual font for much of this work. This work is counterposed to the mainstream view that continues to divide the world of the

[14]First of all, I wish to thank Professor Thomas Kalling for the invitation to be involved in the 2010 Crafoord Memorial Lectures, and for his scholarly hospitality at Lund University. The lecture took as its point of departure chapters Six on networks and Seven on the economy as a whole in my book *Strategizing, Disequilibrium and Profit* (Mathews 2006a), as well as related treatments in Mathews (2006b; 2010). I should like to acknowledge the many discussions I have had on these themes with Professor Charles Snow, at Penn State University, which have deepened my understanding of the issues discussed in this paper.

economy into firms (in fact, large firms) and industries—and ignoring everything in between.[15]

The second anniversary celebrates three decades of work mostly undertaken in Scandinavia in the 'markets-as-networks' tradition, where it is not the actions of individual firms that are the object of study so much as the interactions between firms grouped through vertical supply chain linkages, or through industrial marketing and purchasing activities. In this approach, firms build multiple connections with each other, creating networks of resource dependence and activity proliferation, and view strategizing in terms of how they can influence these inter-firm relationships. The denser the inter-firm connections, and the more numerous, the more the network approaches the concept of a market.[16] This school of thought, which came to public attention through the publication of three books on these themes in the early 1980s, has been developing a consistent empirical and theoretical counter-position to mainstream neoclassical economics and mainstream strategy, where by contrast the firm is stubbornly treated as an independent and utonomous actor, and its embeddedness in networks has been largely ignored.[17]

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[15] See Becattini 1979. The journal in which he published the paper, *Rivista di economia e politica industriale* [Review of Industrial Political Economy] has remained central to debates in Italy over the significance of industrial clusters to the wider economy. Professor Becattini continues as an active scholar, and has a comprehensive website at the University of Florence: http://www.dse.unifi.it/becattini/frame.htm

[16] One of the main contributors to this school of thought, the Swedish scholar Lars-Gunnar Mattsson, coined this term 'markets as networks'—see Mattsson (1997) for the original exposition, and Mattsson and Johanson (2006) for an historical exegesis on the origins of the terms and frames of thought.

[17] The school of thought associated with the Industrial Marketing & Purchasing (IMP) paradigm, which has strong Scandinavian links, has developed many of these ideas, with an emphasis on the categories of resources, activities and relations between firms as actors. I have drawn

A third 30th anniversary celebrates the founding in China of the first Special Economic Zone, at Shenzhen, in 1979/80. Under the guidance of Deng Xiaoping, the SEZ was created as a means of allowing some degree of experimentation in the ailing Chinese economy at the time, to draw from the prior experiences of East Asian success stories like Taiwan, and to go beyond the prior experience of industrial enclaves such as export processing zones and free trade zones. Important as these enclaves were for attracting foreign direct investment and providing employment, they were not kick-starting autonomous industrial development in China itself—which is what Deng Xiaoping wanted to do. The Shenzhen SEZ has turned out to be a spectacular success, growing by more than 25% a year for 30 years, and housing several industrial clusters focused on ICT sectors including electronics, semiconductors, and flat panel displays. As foreseen, the Shenzhen SEZ sparked emulation elsewhere, as China's State Council created further such zones, and these have provided the engine that now drives the Chinese industrial revolution. The Chinese success with clusters is now being emulated in India, and will no doubt kick-start much new industrial cluster activity elsewhere in the developing world.

The fourth 30-year anniversary celebrates the founding of the Hsinchu Science Park in Taiwan in 1980 (and a conferencing marking the event was held at Hsinchu in Taiwan in December 2010). Hsinchu has become a spectacular success in Taiwan, and is home to the country's principal high-tech industries; it remains the gold standard for all high-tech industrial clusters created through government intervention in Asia. It has not only been a powerful generator of wealth, and a means of guiding Taiwan firms from imitation to innovation, but it has even more significantly provided the institutional setting within which Taiwan has developed new industries, from IT and semiconductor chips, to flat panel displays and optoelectronics,

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from these ideas, as in the work on strategy by Gadde, Huemer and Håkansson (2003), without adopting the IMP paradigm in its entirety.

and now to silicon solar photovoltaic systems in the 21st century.[18]

Four anniversaries—two celebrating major scholarly breakthroughs, and two celebrating major institutional initiatives in Asia—provide an appropriate starting point. What I find so interesting is that the scholarship on the industrial cluster phenomenon in the advanced countries, in Europe, North America and Japan, while developing in varied and important ways such as through investigating the evolution of Marshallian industrial districts and markets-as-networks, has failed to take by storm the disciplines of economics and strategy, or even organization theory and entrepreneurship studies. Clusters and other suprafirm phenomena remain on the margins of scholarship, despite their real-world significance. But it is the rise of industrial clusters in China, and no doubt in India as well, spurred by the creation of SEZs, that is undoubtedly going to change the situation drastically. My contention is that the success of these emerging industrial giants of the 21st century cannot be understood without reference to the industrial cluster phenomenon that is embedded within them, housed within such institutional settings as SEZs. All the intellectual machinery developed to understand the rise of clusters in the advanced world is now going to have to be applied in order to make sense of this same phenomenon in the developing world, but in a new context defined by globalization and the emergence of global production networks and global value chains.[19] And the insights generated through the study of emergent industrial clusters in China and India, and their interaction with global firms and the global value chains that they have been creating, will in turn

[18] Hsinchu (or in the standard transliteration, Xinju) means 'new shoot', as in new bamboo shoots. In this sense the name is entirely appropriate, as the Hsinchu cluster has shaped the creation of new industries such as FPDs and PVs as 'new shoots' from the earlier established industries.

[19] An explicit connection between regional issues (industrial clusters) and global production networks in an East Asian setting has been forcefully made by Henry W.C. Yeung (2009).

have repercussions on our understanding as to how such clusters work in the developed world and how they can be created in the developing world—and so the process of mutual scholarly influence will proceed, in a 'circular and cumulative causation' pattern that emulates the processes identified for economies more generally.[20]

Industrial clusters are thus widely recognized today to be powerful engines of wealth generation. They are the focus of this paper. I depict them as microcosmic versions of the economy at large—and full of interesting and challenging detail that is passed over in silence by mainstream economics and even by much of strategy. In this paper I discuss how firms enlarge their strategic options through forging connections with each other and in enhancing and deepening the interfirm knowledge flows that result . Firms that form part of a network have access to many more resources than would be available to them individually, and such firms can contract with third parties to accomplish many more activities than would otherwise be under their control, thus expanding the market that is available for their products or services. And as the market expands, so the scope for specialization and intermediation grows (exactly as foretold by Adam Smith, and earlier by Italian political-economic theorists like Antonio Serra and Giovanni Botero).[21]

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[20] The phrase 'circular and cumulative causation' was first used by the Swedish development economist Gunnar Myrdal, in his 1960 book *Asian Drama*, and was taken up by the brilliant Cambridge economist Nicholas Kaldor, as a way of encapsulating the real development processes in real economies. Circular and cumulative causation (C&CC) reasoning will figure prominently in this paper.

[21] Adam Smith's *Wealth of Nations* (1776) needs no introduction. Italian scholars who anticipated his ideas and elaborated on the role of urban clusters more forcefully must certainly include Antonio Serra (*Breve Trattato delle cause che possono far abbondare li regni d'oro e d'argento dove non sono minere*, 1613: Brief treatise on the causes that can increase wealth in terms of gold and silver where there are no mines) and before him Giovanni Botero (*Delle cause della grandezza delle citta*, 1590: Causes of the greatness of cities). On the significance of their ideas for a long-lost

This generates a series of positive feedback loops that can be described as a chain reaction, resulting in the cumulative and circular causation of enhanced production capacities in clusters; this gives a "spring" or "bounce" to a network that surpasses whatever is available to a firm on its own. The network can reconfigure itself as needed, with inter-firm relations being activated, de-activated and re-activated as circumstances warrant, leading to a shuffling and reshuffling of the resources embodied in these firms. This gives rise to the evolutionary dynamics that generate knowledge spillovers, common resource pools and interconnections that can then be translated into synergies and systemic returns—that are better known in economics as increasing returns. In this paper I characterize the reshuffling of resources within the cluster as an analogue to the reshuffling of the genome of a biological species through Darwinian experimentation and selection; and the shifting activity networks in the cluster that are made possible by this resource reshuffling as the phenotypical expression of these changes in genotype. With due regard to the limitations of biological analogies in the business world, it strikes me that this is undoubtedly a fruitful way to view industrial clusters and to gain insight into the sources of their advantages over the single, isolated firm.[22]

Such are the essential advantages of working in networks. The downside is that a firm gives up some of its strategic autonomy when it links up with other firms. To be part of a flourishing network is good; to be part of a declining network is obviously

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tradition of political economy, but one which is highly relevant to the study of clusters, see Reinert 1999.

[22] Nelson and Winter (1973; 1982) in their justly famous *Evolutionary Theory of Economic Change* characterize intra-firm routines as the economic-level analogue of the replicators of a biological system. But the problem is that this notion of routines as replicators does not admit of an easy identification of genotype and phenotype, which is fundamental to the biological conception, whereas to take the argument to the cluster level admits of such an analogue in terms of cluster resources and activities.

bad. This is an unavoidable strategic trade-off. Firms can hedge these uncertainties by forging links with multiple networks. This is a strategy that becomes more feasible as the global economy exhibits multiple connections between economic agents—a process that is accelerating, according to reports from UNCTAD (2001), UNIDO (2002) and the OECD (1999; 2001).

The paper is structured as follows. I first identify the range of business and institutional issues that come within the purview of the "network organizational paradigm"—encompassing networks, clusters and various kinds of suprafirm structures. Next I pose the issue of strategizing in such settings by focusing on goals that are achievable only by firms acting in concert (and not individually) and that go beyond the simplicities of neoclassical economics (such as agglomeration economies). As in the strategic discussion of the firm, I focus on the key attributes in networks that are amenable to management control, namely activities (that generate revenues), resources (that support activities) and routines (that link resources to activities). I give a meaning to these categories at the suprafirm level, and to strategic goals associated with them, such as the pursuit of increasing returns through extending activities and specialization; the capture of resource complementarities through interconnectedness in a network setting; and the development of network-level capabilities (or population-level learning) through repeated application of interfirm routines. In doing so, I seek to provide an original account of network strategic dynamics in terms of intermediation and disintermediation in the setting of activities; of asset mass efficiencies and other characteristics of resource complementarities; and forms of economic learning (or what Foss (1996) aptly calls the development of higher-order industrial capabilities) associated with the improvement of interfirm routines. Based on these insights, I then develop an account of the Marshallian and Schumpeterian evolutionary dynamics of industrial clusters, to recapitulate the emergence of systemic characteristics and the cluster advantages identified with great acuity by Marshall—elaborated in the light of more

recent understanding of evolutionary processes as featuring punctuated equilibria, and new evolutionary insights from economic geography. Finally I frame a series of Theses as to how industrial clusters work, drawing on the 200-plus years of experience with such clusters and their external economies in the advanced world, and applying these lessons to the newly emergent clusters in China and India, and their inevitable interlinkage with global production networks and value chains. Industrial clusters, I argue, are thus central to the three great trends that are shaping our industrial civilization — globalization, industrialization and urbanization.

The network/cluster organizational paradigm

Economies consist of multiply-connected value chains, or criss-crossing value-adding processes, that can be described as value constellations or value configurations or what Alderson called (in a wonderful terminological innovation, transvections)—or, in other words, as complex and highly connected interacting systems for the production of value.[23] Rather than seeing markets or hierarchies (firms) as the primal economic institutions of a business system, and networks as a 'hybrid' between the two—as in the case of Williamson (1985)—many

[23] Alderson (1965) introduced the term transvection as a term to capture the total system of supply relations culminating in a product offered to consumers. It is a value-chain counterpart to the notion of a single transaction. Alderson's focus was on the way that management initiatives would carry implications throughout the transvection embodying the firm—just as we say today that firms strategize around the upstream supply links and downstream customer links. The continuing terminological confusion over value chains, networks, constellations etc (see Normann and Ramirez 1993; Stabell and Fjeldstad 1998) only underlines the significance of such a powerful terminological innovation. In her PhD thesis, Hulthén (2002) discussed the Aldersonian notion of transvection analysis and its use in the dynamic analysis of distribution networks

scholars have adopted a network paradigm, and see markets as networks and firms as networks, each connected to the other to make a seamless web of connections (Thorelli 1986; Jarillo 1988; Maskell and Lorenzen 2004). I propose that the strategy field re-adopt the Aldersonian term ***transvection*** as its primary object of interest (as opposed to the transaction). As transvections forge connections with each other (just like neurons in the brain) so dense networks are formed that generate extra value-added. In such a setting, pure atomistic markets, at one extreme, and pure hierarchical unified firms at the other extreme, are merely the end-points of a spectrum of real interfirm relational dynamics. In such a setting, the management of the network becomes just as important as the managing of the firm itself—and the development of collaborative capabilities becomes a prime feature of entrepreneurial success.

To view firms in this setting is to pose a novel set of challenges for managers. Miles, Snow et al (1997; 2000) make the point that such a framework, or paradigm, encourages managements to make investments in such intangibles as enhanced collaborative capabilities and shared routines between partner firms—whereas earlier frameworks, based on the atomistic firm, create unnecessarily high obstacles to these strategic investments. They define collaboration as an important meta-capability needed in conditions of inter-firm dependence. Likewise Ritter (1999) defines a category of 'network competence' that enables firms to manage multiple relationships—whether they be found in strategic networks, clusters, platforms or industrial networks.

The concepts that I group together as 'suprafirm structures' include production networks and global value chains, industrial clusters or industrial districts, on which a voluminous literature exists, as well as development blocs (Dahmén 1950), growth poles (Perroux 1988), filières (Antonelli, Petit and Tahar 1992), production systems (Storper and Harrison 1991), local production systems (Crouch et al 2001), technological systems

(Carlsson and Stankiewicz 1991) and competence blocs (Carlsson and Eliasson 2003), *innovative milieux* (Camagni 1995; Aydalot and Keeble 1988) and regional innovation systems (Cooke 2001; Asheim and Cooke 1999). All these entities may be grouped together in what Foss (1996) calls instances of a meso-level of analysis (between the micro and the macro) while Richardson referred to them as instances of the 'organisation of industry' (as opposed to industrial organization, with its neoclassical economics overtones). In the category of suprafirm structures I also include such entities as (technological) platforms (Gawer and Cusumano 2002) and modular systems which impose a structure on multiply-connected firms. The point is that all of these meso-level categories (or suprafirm structures) have no place in mainstream neoclassical economic analysis—and are duly ignored in such analysis. But they are real, and important. They are the engines of wealth generation.

Production networks and global value chains

Networked systems of production are now recognized as important alternative organizational forms to those found at the extremes of a spectrum that has atomistic firms at one end and totally integrated systems (firms, hierarchies) at the other end. Strategy scholars such as Thorelli (1986) and Jarillo (1988; 1989) provided early recognition of this reality, but it was in the sphere of production itself, and the changes unleashed as large established firms started to outsource portions of their value chain to lower-cost specialist producers.

Consider the case of the specialist networked production firm, Li & Fung, based in Hong Kong. This firm has no brand name, yet it is one of the most important producers of finished articles, particularly textiles and garments, providing manufacturing and logistics services to retail outlets such as The Gap or Tommy Hilfiger. How then does Li & Fung operate? This firm has no manufacturing facilities of its own. Rather it manages a vast network of contractor firms, numbering upwards of 7,500 firms

at any one time, each of which is ready to become involved in a customized value chain created by Li & Fung in response to an order received (Mathews 2002). This is the "springiness" in the Li & Fung network. A potential customer approaches it with an order for, say, 10,000 specially sewn shirts, and Li & Fung can respond by creating a new network out of its list of contractors, adapted to the purpose. The art for Li & Fung is to extract commissions from such deals. The art for the contractor firms is to be ready, but not wholly dependent on Li & Fung for custom, since there can be lean patches when there is no work available. Thus the network is 'managed' (or governed) by a 30-70 rule—no firm is to do less than 30% of its business with Li & Fung, and no firm is to do more than 70% of its business with the network. Li & Fung wants to deal with firms that are committed—but not dependent. In this way the network reduces overheads to a minimum, and achieves a competitive advantage for the participant firms over a conventionally structured firm.

Production networks first came to prominence in the Japanese automotive industry, where firms such as Toyota were able to achieve enormous advantages over their western competitors through outsourcing much of their production activities to supplier chains that cascaded through multiple levels, with 'first tier' suppliers providing whole subsystems (such as gearboxes and transmission systems), and second tier suppliers providing parts and components to these suppliers, and third-tier and even fourth-tier suppliers providing smaller and smaller and more generic components to those above them in the pyramid. This organizational model allowed Toyota to achieve unprecedented flexibility combined with quality, through the 'just-in-time' production systems pioneered in this setting, in a way that had proved to be beyond the capabilities of their standardized mass production competitors. The 'Toyota production system' was then quickly emulated by other Japanese automotive producers, and then by Japanese mass producers of electronic and other products, and it soon became a new paradigm in itself as an alternative to the conventional Fordist paradigm and its organizational creations such as the divisionalized firm. By the

1980s the production network model was being adopted by advanced firms in the west, along with an outsourcing strategy, and since then it has become the norm in global industries such as electronics—where the networks are global in scale, and the organization and governance of such networks is coming to be the exclusive preserve of specialists such as Li and Fung.

Production networks are important not just in themselves, as alternative organizational forms to integrated firms (domestic or global, as in multinational enterprises) but because industrial clusters in emergent industrial powers like China and India take their shape today from their interaction with global production networks and the flagship firms that create and guide them. Key firms initiating the formation of these GPNs could be producers (like Toyota, or Canon) or buyers, such as retail chains like The Gap or Tommy Hilfiger. While much analysis has focused on these 'flagship firms' the real interest lies in the network itself (as a suprafirm structure within the global economy) and its impact on local cluster formation.[24]

Strategic networks

The concept of *strategic network* connotes a purposive activity, where network construction depends on strategic initiative, and where network growth and sustained development depend on firms capturing not just competitive but collaborative

[24] The literature on Global Production Networks (GPNs) has expanded rapidly, from early beginnings by scholars such as Gereffi (1996) with his notion of global commodity chains. An emphasis on the GPN itself, as a systemic phenomenon, can be found in numerous works such as Bair (2002; 2009), Ernst and Kim (2002) and Henderson et al (2004) and in related work by Manning (2008). The scholars associated with the Institute for Development Studies at Sussex University (UK) have been particularly influential in this matter; see the special issue of the IDS Bulletin which defines key terms and perspectives (Gereffi, Humphrey, Kaplinsky and Sturgeon 2001) which derived from a meeting of scholars of the GPN phenomenon at the Rockefeller Conference Center at Bellagio in Italy.

advantages from their mutual engagement in the network.[25] Successful strategizing depends on both—as reflection on the formation of sub-contracting networks by automotive firms such as Toyota, or supply networks by PC firms such as Dell, testifies. The economic significance of networks is that they generate the capacity to adapt to changing circumstances as a total entity, i.e. as a network, rather than as individual firms on their own. Firms draw considerable advantages from their membership of a network that is adapting as a totality to changing circumstances. The Toyota supply chain adapts, for example, to changing consumer preferences in cars, e.g. from petrol-driven engines to hybrid engines (electric and petrol-driven) *as a totality*, with each individual firm within the network making its own small adjustments but no member of the network having to retool totally to meet the new circumstances. Networks and chains of activities thus enlarge the scope of strategizing behavior, from the firm, to the firm embedded in its connections.

The literature on strategic management and strategic entrepreneurship has started to register the significance of networks in recent years. The concept of a *strategic network* has been developed to capture this recognition, where firms are envisaged as using their relational assets to capture "collaborative advantages" in addition to the traditional emphasis on competitive advantages (Jarillo 1988; Dyer and Singh 1998; Gulati, Nohria and Zaheer 2000). Successful strategizing depends on being able to capture both kinds of advantage.

[25] See Gulati (1999), and Gulati, Nohria and Zaheer (2000), for expositions of the strategic network framework. Barringer and Harrison (2000) probe the empirical data for the reasons that firms strategize in a network context. Chung and Kim (2003) introduce the important mutuality dimension, and discuss how firms involved in supplier networks, i.e. the suppliers themselves, benefit from such involvement. Hill and Mudambi (2010) provide a recent review of cluster developments 'far from Silicon Valley' from a strategic management perspective.

Industrial clusters

Firms cohere together in various kinds of networks and clusters; there are networks built on networks; indeed the entire economy can be viewed as interconnected networks of networks. Networks grow, and become clusters. Such interconnected firm aggregates are well recognized and indeed are becoming the object of increasing attention—due to the outstanding success of such high tech clusters as Silicon Valley in the USA, and other science-driven clusters like Research Triangle Park in North Carolina, or the Hsinchu district in Taiwan where all the country's major IT and semiconductor activities are co-located, or the Jutland region of Denmark with its radiofrequency cluster (Dalum 1995) and its fascinating wind turbine cluster (Garud and Karnøe 2003; Andersen and Drejer 2008). These various clusters stand testament to the power of clustering as a means of enhancing advantages, in newly developed as much as in developed countries.

It is widely recognized that the success of a Silicon Valley owes much to highly specialized complementarities arising between neighboring firms—something that cannot be accounted for in simple capital and labor terms in a production function (Foss 1996). Clusters are being seen as the setting in which entrepreneurial and innovative activities can best be understood, as well as the more traditional activities of production of goods and services; this in itself is a powerful departure from earlier traditions that focused on firms acting as individual strategic entities. In the thirty years that have elapsed since Becattini (1979) first pointed out the salience of the Marshallian 'industrial district' model to Italy's post-war economic development, and sparked feverish work identifying, counting and classifying the various kinds of firm concentrations found in Italy and throughout Europe (including famous districts like the Prato textile district, or the Sassuolo ceramic tiles district, or the Carpi knitwear district), the world of scholarship has come to a relatively advanced level of understanding as to what makes industrial clusters work. From the excesses of

enthusiasm linked to the view of districts as being able to generate 'flexible specialization' through their operations, as alternatives to large integrated firms, there has developed a nuanced understanding of how industrial districts survive and adapt to changing conditions, and how they combine small-firm features with large-firm guidance. The judgment of Bennett Harrison that such districts are not just 'new wine in old bottles' remains valid.[26] At the end of the 1990s, Michael Porter added his voice to those analyzing and advocating clusters.[27] But the

[26]The Florentine scholar Giacomo Becattini is generally regarded as the father figure of industrial district studies—from his 1979 article and the earlier work in Italian (Becattini 1962). His work has been complemented by other notable Italian scholars such as Sebastiano Brusco ('The Emilian model'), Cristiano Antonelli, Patrizio Bianchi, Gianni Lorenzoni, Franco Malerba (regional innovation systems) and Carlo Trigilia and district specialists such as Gabi Dei Ottati who has specialized in the Prato industrial district through all its twists and turns. Piore and Sabel brought much of this Italian scholarship to the attention of the English-speaking world in their path-breaking book The Second Industrial Divide (1984) but their excess of enthusiasm for a quasi anarchic description of life in the districts (a firm as entrepreneur one year, a sub-contractor the next year, a joint venturer the year after) has been tempered by more nuanced scholarship since (such as Lazerson and Lorenzoni (1999). Bennett Harrison (1992) provided an excellent overview that summarized findings for the 20th century, while Klepper (1996), Cooke (2001), De Bresson and Hu (1999), Best (2001), Nakano and White (2006) and Green (2001) reveal the power of cluster analysis applied to specific regions. O'Mara (2004; 2010) makes telling points as to the potential for transferring the success of Silicon Valley to other locations, while Bresnahan, Gambardella and Saxenian (2001) summarize their studies of emergent 'Silicon Valleys' in places such as Ireland, Israel and Taiwan, identifying five 'deep regularities' associated with all such developments: access to highly skilled technical labor; access to managerial labor; institutional forms favoring new firm formation and firm building; connections to markets; and a combination of cooperation with competition.

[27]Michael Porter opened the way to his cluster studies with the identification of a role for 'related and supporting industries' in his 1990 framework for analyzing national competitive advantage. But he focused on clusters themselves, particularly at a state level in the US, from his 1998 and 2000 papers on (Porter 1998a; 1998b; 2000), leading to a decade of sustained work that has raised public and policy awareness of clusters' significance (see Porter 2003, and most recently, Delgado, Porter and Stern 2010).

industrial district phenomenon is now seen to encompass not just the advanced world, but even more significantly the developing world—such as in India, Pakistan and countries in East Asia.[28] Most notably the phenomenon can be identified as the core driving factor in China's resurgence as an industrial power—particularly in the setting of the Special Economic Zones (SEZs) to be discussed below.

Markets as networks

The industrial marketing school of thought has been pursuing a network paradigm for many years, especially in Scandinavia where the school has most adherents. The approach was

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Porter's methodology tends to be comparative static in approach, utilizing cross-sectional and regression studies to gain insight into cluster dynamics—but by their very nature, such studies must give limited insight compared with longitudinal and explicitly dynamic approaches. Having said that, it remains the case that longitudinal studies of clusters are extraordinarily difficult to perform, as reference to Delgado, Porter and Stern (2010) confirms. The British scholars Ron Martin and Peter Sunley (2003) have subjected Porter's work on clusters to sustained conceptual critique, and make some effective points—but without attracting any response from Porter (which is normal: he never seems to respond to critics). However they fail to consider whether his concept of cluster can be applied to the new cases in China and India; in my view, Porter's cluster ideas are (ironically) probably better applied in China and India than in the US (once data comparable to his US Cluster Mapping Project can be assembled).

[28] See the studies by Schmitz (1995) of the Sinos valley footwear cluster in Brazil; the study of the Pakistan surgical instruments cluster in Siot by Nadvi (1999), a student of Schmitz; and others. Yamawaki (2002) provides an historically informed account of 14 clusters in Japan. Wei (2009) provides an informative account of the emergence of the 'Wenzhou' model of a footwear cluster in China, while Zhou and Xin (2003) on the ZGC cluster in Beijing and Zhu (2009) are two examples from a burgeoning literature on Chinese clusters. Ernst et al (2001) provide insight into the contrasts between Taiwan and Italian clusters. On the development of Special Economic Zones as an outgrowth of the earlier experiences with Export Processing Zones and Free Trade Zones, first in China and then in India since 2001, see the works by the Indian scholar Aradhna Aggarwal and her colleagues (e.g. Aggarwal et al 2009).

christened as one involving 'industrial marketing and purchasing' as a conscious alternative to the emphasis on consumer marketing in the mainstream marketing literature.[29] Eventually called the 'markets as networks' approach, it adds a system dimension to the simple portfolio approach to procurement, where instead of the former emphasis on selecting from a given portfolio of "given" relations, there has emerged a focus on the dynamics of the relationships themselves. This means bringing into focus the shared routines that exist between suppliers and customers, and the enhancement of the mutual capabilities of the parties involved. The concept of 'system sourcing' takes the process a step further, where instead of considering suppliers and their links, the strategizing firm thinks in terms of a system sourcing firm, thus reducing the complexity of a supply chain (Araujo, Dubois and Gadde 1999; Dubois and Pedersen 2002). Strategizing in such an interconnected context involves choice of connections, or relations, between firms, both actual and potential (Gadde, Hümer & Håkansson 2003). The insights offered from this perspective are profound, when given an evolutionary dynamic in terms of networked firms making new connections, breaking old connections, and reconfiguring their resources, activities

[29]The original text setting out this approach -- the book edited by Håkan Håkansson, published in 1982: *International Marketing and Purchasing of Industrial Goods: An Interaction Approach*—makes this perspective very clear. Several key texts in this 'IMP' tradition have since been published, such as Håkansson and Johanson (1992), Håkansson and Snehota (1995) and a reflective view both forwards and backwards, in Ford and Håkansson (2006). Critical contributions that have helped to clarify the network view, seeing it originating as concerned with dyadic change and evolving to more general networks of relationships, include Halinen et al (1999), Holmén and Pedersen (2003), and on the tasks for management in such networks, Ritter et al (2004). An attempt to reach across to the parallel strategic management literature was made in Gadde et al (2003). For a robust critique decrying the school's lack of empirical engagement, see Brennan and Turnbull (2002). At the same time, the US school of industrial sociology, associated in particular with the work of Harrison White, has developed very similar ideas ('markets from networks') and very similar terminology—and yet the cross-referencing between the two schools seems to be non-existent.

and routines—and the insights are amplified when supplemented by those associated with the US school of industrial sociology (White 2001). But the school has yet to make any discernible link with the new suprafirm structures and industrial clusters emerging in China and India—and perhaps a new focus on these current trends outside Europe would revitalize the IMP research program, and generate more cross-connections with parallel fields like strategic networks and global production networks.

Development blocs

At a higher level of recursion, the idea that firms work together in wholes or structured clusters that succeed each other in time traces its intellectual origins to the idea of *development bloc*, conceived as the structural attribute of clusters that account for their success. The category was introduced and defined by Dahmén in 1950, based on his studies of entrepreneurship in the Swedish economy, as "sequences of complementarities which by way of a series of structural tensions, i.e. disequilibria, may result in a balanced situation." (1989: 111)[30] Such a suprafirm system provides a striking description of how firms may collectively strategize in the context of a disequilibrium economy, and build on each others' efforts to improve their own prospects. Carlsson and Stankiewicz (1991) built on the idea of a development bloc with their notion of a *technological system*, viewed as a dynamic economic structure that consist of

[30] As explained by Carlsson et al (2002): "The basic idea is that as an innovation creates new opportunities, these opportunities may not be realized (converted into economic activity) until the pre-requisite inputs (resources and skills) and product markets are in place. Each innovation, therefore, gives rise to a 'structural tension' which, when resolved, makes progress possible and may create new tensions and which, if unresolved, may bring the process to a halt. Thus … Dahmén's concept already is dynamic, representing one of the first attempts to apply Schumpeterian analysis. It incorporates the notion of disequilibrium and focuses on the role of the entrepreneur. The output of the system not only grows over time but also changes in character and content." (2002: 235-6)

networks of firms, R&D institutions and other specialist bodies, all focused on a set of technologies rather than on an industry or a geographical cluster. Carlsson and Eliasson (2003) have taken up the concept and renamed it *competence bloc*—to emphasize that such a collective capability is needed to support and sustain technological innovation. It represents the systemic counterpart to the consideration of market demand as well as supplier competence in the microdynamics of technological trajectories.

Platforms

Some networks or clusters are developed around technologies rather than geographical place—and are aptly known as (technological) platforms. As such, they can grow to be very large, as when firms strategize around the creation of platforms such as the Palm operating system for Personal Digital Assistants (PDAs), or the Symbian platform for smart phones, or the Windows platform for Personal Computers (PCs). In each case, the platform can draw together thousands of firms that are linked by complementarities, such as applications developers, hardware components providers, and service providers. All these firms are inter-dependent and pursue strategies contingent on those followed by the other platform members -- albeit following the strategic lead of a network architect firm that seeks to make its platform the dominant system in the industry.[31]

[31] See Gawer and Cusumano (2002) for the original exposition of the 'platform leadership' concept, and Gawer and Henderson (2007), Gawer and Cusumano (2008) as well as network economists such as Evans (2003) for subsequent elaborations. This perspective on industrial platforms remains a potent source of insight, not just into the individual platforms identified and explored in this manner, but into all suprafirm structures, including clusters, as well.

R&D networks

Suprafirm structures come in many forms, such as production networks, marketing networks, and R&D networks. The case of R&D networks, where several firms join forces with R&D institutions and with each other on some specific innovation project (while they might be competitors on other projects and in other product markets) have come under increasing scrutiny. An example from a real network, or set of networks, involving biotech and pharmaceutical firms collaborating in Sweden, is shown in Fig. 3.[32]

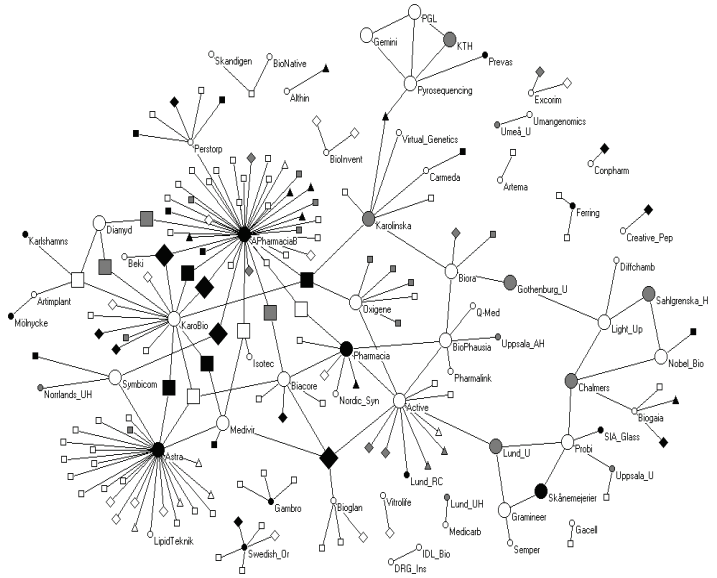

Fig. 3 The Swedish network of R&D collaborations in bio-pharmaceuticals

Source: McKelvey, Alm and Riccaboni (2003), Fig. 1

[32]McKelvey, Alm and Riccaboni (2003) provide the background, and the original chart. Note how many of the firms in this cluster belong to multiple networks, while there are strong nodes (such as around Pharmacia) that dominate the network landscape. Waluszewski (2004) has a highly original account of this Uppsala-based biomedical cluster, focused on the contested role played by Pharmacia and its mergers, first with Upjohn in 1996 and then with Pfizer.

The reasons why firms in the advanced countries seek to pool their development efforts within R&D consortia, and the nature of the benefits they derive, is now the subject of a burgeoning international literature. The comparative static economic arguments tend to focus on the *spillover effects* of R&D, creating a socially useful externality. According to this reasoning, firms enhance social welfare through their research activities, but this may depress their incentives to continue, unless a form of R&D collaboration can internalize such an externality. These arguments are of necessity couched in comparative static cost terms, with consortia seen as pooling costs, and with the inevitable assumptions that vitiate much economic reasoning, e.g. that cooperation either involves all firms in an industry or none (compared to the reality that cooperation usually involves a small subset of firms), and that the benefits and costs are computed entirely in comparative static terms. Empirical testing of these points was scant until comprehensive microeconometric studies of Japan's R&D consortia and U.S. consortia such as Sematech demonstrated clear benefits to participants and to R&D expenditure levels by participant firms generally (Sakakibara 1997; Link, Teece & Finan 1996).

In the case of the U.S. semiconductor industry, the creation of Sematech arguably enabled IC producers to form closer relations with developers of equipment and materials, giving them both a competitive edge over their Japanese rivals. So there was economic learning going on by one national industry from another, and in terms of the routines established linking firms at different levels in the value chain. R&D consortia, such as Sematech, can be fashioned through private initiative or through public policy. From a resource perspective, the rationale and source of success is clear: it is through managed sharing of resources. Firms participate in such consortia in order to acquire access to knowledge and techniques that would be too difficult or expensive for each to acquire individually. The consortium can allow Smith's division of labor to operate. Each firm or group of firms can specialize in certain aspects of a

problem, while the consortium as a whole pools the results for the benefit of all. In addition to the learning that goes on within such arrangements, there is also a longer-term institutional learning concerning the optimal institutional arrangements for such experiences—long-term vs. short term consortia, private financing vs. public financial support, prototype development vs. component standardization, and other such choices, all of which boil down to the routines linking the consortium participants. China too is developing clusters through an accelerated spin-off process from national R&D institutions, and notably from the Chinese Academy of Sciences, which operates as a potent source of high-tech, specialized firms that tend to cluster in the regions of Beijing or Shanghai.[33]

The extended enterprise and industrial networks

All of these suprafirm structures capture different aspects of the interlinkages between firms, or the inter-dependencies, when the structures are viewed as self-sustaining wholes, or systems. The point of interest in such a perspective is the *systemic gains* that become available to the firms participating in the structure—in the cluster, or network, or consortium or platform. A way of capturing the embeddedness of firms in multiple relationships, extending upwards through their supply chains and downwards through cascading transvections to their customers, is to describe value flows associated with the *extended enterprise*, in a strategic setting (Kinder 2003). Such a perspective helped to spawn the *industrial network* approach to marketing and procurement, and now informs the strategic conception of interconnected value chains of suppliers and customers as *ecosystems* (e.g. Pitelis and Teece 2010).

[33]Shulin Gu's account of such spin-off processes, in her 1999 study of China's technology policies, provides an interesting example. She argues that market reforms are counter-productive in the absence of organizational shifts away from top-down, hierarchical organization typical of the large state-owned enterprises. This is consistent with industrial cluster reasoning.

The economy may thus be viewed as a totality that is highly structured, consisting of networks of networks and other suprafirm structures. None of these suprafirm structures arise spontaneously, or deterministically: they are instead the outcome of strategizing, on an individual as well as a collective basis. The object of strategizing in each case is to capture the 'extra' that is available from the interactions between the agents or institutions. Following Leibenstein (1996), and Niosi (2002), these may be characterized as 'x-efficiencies' of the economic structures. The goal of strategizing can then be formulated as the capture of the x-efficiencies available within such structures, viewing them from a strategizing perspective as potential systems, and capable of yielding *systemic* returns from the totality. In the words of Tesfatsion describing a simulation approach to this totality:

> [T]he actions of each unit depend upon the states and actions of a limited number of other units, and the overall direction of the system is determined by competition and coordination among the units subject to structural constraints. The complexity of the system thus tends to arise more from the interactions among the units than from any complexity inherent in the individual units per se (Tesfatsion 1997: 534)

The multiple interactions that are generated within these various kinds of emergent structure shape the circulation and sharing of resources between firms, the building of common routines, and the creation of multiply -complementary chains of activities. The mainstream economics view of clusters and suprafirm structures is that they can generate "agglomeration economies" arising from contiguity, such as through reduction in transactions costs, transport costs or other such sources. But agglomeration economies can be captured by atomistic firms simply by co-locating; they do not imply any level of purposive action by the firms involved, nor any degree of interdependence. Thus the static concept of agglomeration economies hardly begins to account for the range of benefits available to firms through clustering, and is in any case an *ex post* explanation for some phenomenon where I wish to

introduce strategizing calculations. The central goal of this paper is to provide an original *strategizing account* for how firms can build and capture agglomeration economies through network and cluster formation.

But first it is important to register how the concept of industrial cluster is spreading from its roots in Europe, the US and Japan, and is now making considerable inroads in China and India, and beyond them in the rest of the developing world—through the agency of Special Economic Zones.

Special Economic Zones in China and India

While the rise of industrial clusters or industrial districts in Europe has been widely documented, the story in the rest of the world is less well known. Clusters in China and India and in many other countries have been proliferating—but usually as a result of direct government sponsorship, rather than in the spontaneous fashion in which clusters evolved in the developed countries. This is in keeping with the way that countries that are developing accelerate their catch-up with latecomer institutions—a prime one being the SEZ, which can be home to many industrial clusters.[34] As reported by Aggarwal (2010), since the 1990s there has been a sharp increase in the number of SEZs around the world—from 79 SEZs across 29 countries in 1975, to 3500 SEZs across 130 countries in 2006. The mean number of zones per country increased from 3 to 27 in this

[34]On the possibility of creating clusters *de novo*, see the World Bank study *Growing Industrial Clusters in Asia*, edited by Shahid Yusuf, Kaoru Nabeshima and Shoichi Yamashita (2008), which asks the pertinent question: Can clusters be made to order? This question is answered in the affirmative (with reservations) after looking at cases such as the emergence of Hsinchu Science Park in Taiwan (discussed below), ICT cluster development in Singapore, the IT clusters in Bangalore, the high-tech clusters in Seoul, and the efforts to seed viable clusters in Japan.

period, while employment within SEZs tripled in ten years, from 22.5 million employed in 1997 to 66 million in 2006. China alone employed 40 million people in SEZs in 2006.

China: Special Economic Zones

China's Special Economic Zones grew conceptually out of the earlier trial experiences with export processing zones and free trade zones, which tended to be enclaves generating few forward and backward linkages with the local economy. But SEZs as conceived by Deng Xiaoping, their principal promoter, were to be grander affairs, as designated zones where local authorities would be encouraged to try out new policies to promote local growth and foreign direct investment. In these enterprise zones, the firms that are counted as members enjoy the rule of law, special tax advantages, freedom from administrative micro-management and imposition of tariffs, as well as the no less important infrastructure advantages of good roads, ports, rail and air links; superior housing for workers and professional staff; health and education services; and utilities supply (water, gas, electricity). The Shenzhen SEZ in southern China has been a phenomenal success story in this regard, growing at 25% per year (on average) for 25 years, from 1980 to 2005, and reaching a population of 12 million in the confines of what is now a large city. Indeed Shenzhen is now coming up against its resource limits in terms of land available. It is home to multiple industrial clusters, mostly focused on ICT products and activities.[35]

[35]On Shenzhen, see Guo and Feng (2007), and Yeung et al (2009) for useful descriptions and analyses. Shenzhen's annual growth rate averaged 44% in the very early years, from 1980 to 1986; it averaged 29% in the years 1987 to 1995; and 19% in the years 1996 to 2003. Over the same years, China's overall growth rate was averaging 10% per year or less. In 2006, Shenzhen's per capita GDP was more than four times the China overall average: US$8,619, compared with China's countrywide average of around $2000. Shenzhen's GDP is now rapidly catching up with that of Hong Kong. It is in

China has now developed two powerful 'growth poles' with their corresponding industrial clusters and supply chains, around the Pearl River Delta (PRD) in the south (including Shenzhen, Guangdong, Dongguan and, by most estimates, Hong Kong as well) and the Yangtze River Delta (YRD) in the east, with Shanghai as its principal cosmopolis, but numbering cities like Suzhou and extending west into Jiangsu and Zhejiang provinces. Shenzhen, at the core of the PRD, was the first, and attracted a lot of inward foreign direct investment (FDI) from both Hong Kong and Taiwan, largely in labour-intensive production including textiles, garments, toys and extending up the value-added ladder to electronic goods and IT, such as desktop computers.[36] As its industrial concentration grew, and its exports, so industrial clusters where firms agglomerated around individual towns and cities also emerged. Since 2000 these have been identified by the Guangdong provincial government as 'specialized towns' and there are now more than 200 of them in the PRD.[37]

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this sense that industrial clusters may be viewed as engines of development. On the greater Pearl River Delta development zone, amongst a large number of publications the work by Enright, Scott and Chang (2005) emphasizes the role played by industrial clusters, while the study by Edith terry (2008) emphasizes the growth dynamics of the region..

[36]The industrial districts that have emerged in Guangdong include Xiqiao (Nanhai) for textiles; Dachong for rosewood furniture; Nanzhuang for ceramics; Shuikou for water heating; Qingxi for electronic products; Shunde for electrical household goods; Ronggui for air conditioning units; Shaxi for leisure wear; Human (Dongguan) for clothing; and Pengjian (Jiangmen city) for motorcycles (Barbieri et al 2010; Arvanitis et al 2006).

[37]Barbieri, Di Tommaso and Huang (2010) as well as Bellandi and Di Tommaso (2005) provide description and analysis of the 'Specialized Towns' (STs) phenomenon, which has obvious affinities with the emergence of specialized 'Industrial districts' in Europe in the 19th and 20th centuries. The work on STs has been conducted in the setting of the 'China-Italy' study program organized by the University of Ferrara, led by Professor Di Tommaso, and described in a book-length report in Italian, *Industria contemporanea nella Cina meridionale: Governi, imprese e territori* [Current industry trends in southern China: government, firms and spaces], by Elisa Barbieri, Marco Di Tommaso and Lauretta Rubina (Carocci 2009).

But the industrial clusters in the Pearl River Delta now find themselves confronted by severe competition from a new batch of industrial clusters located in the even larger and more industrially concentrated Yangtze River Delta, centred on Shanghai and extending west through Suzhou and into Jiangsu and Zhejiang provinces. This region with a population now approaching 80 million is comparable in GDP and population to a mid-range country, and is rapidly developing industrial clusters at a higher level of value-adding than those in the PRD. For example Suzhou in the YRD is now the world's most concentrated cluster of production of laptop PCs—whereas production in the PRD, and in Dongguan in particular, has remained focused on desktop computers, and has not made the leap to laptop PCs.[38]

No less successful is the Beijing Technology-Development Area (BDA), home to many leading MNCs such as Nokia and their supplier chains (such as the case of Xingwang industrial park). Nokia has taken the initiative together with partners in Beijing to build its largest joint venture in China and the largest

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The 'Specialized Towns' program was launched by the Guangdong provincial government in 2000, in an attempt to identify potential platforms for industrial upgrading; by 2003 a total of 71 such Specialized Towns had been identified, and five years later in 2008, the total had grown to 229. Arvanitis and Jastrabsky (2006) refer to the phenomenon by its Chinese designation as *zhuanye zhen*, which they translate as 'specialized cluster' which might be a better English rendition, and closer to the spirit of 'industrial district'. Fan and Scott (2003) add their own conceptual and econometric insights to bring out the significance of these Chinese clusters.

[38] Industrial sociology studies informed by both regional perspective and global value chains reveal the details of this industrial upgrading dynamic being played out between the industrial clusters in the PRD and those in the YRD—such as the studies by Chen (2007) and by Yang (2009). Chen opened up the topic by focusing on the two main attractors—Shanghai and Hong Kong—and then on important hubs of clusters such as Dongguan in the PRD and Suzhou in the YRD. Yang followed up with analysis based on a series of interviews on the ground in both the PRD and YRD, bringing out the strategic interaction between the flagship firms, particularly Taiwan IT firms, and the cluster participants.

mobile communications production cluster in the world in the Xingwang park. It is a purpose-built cluster with Nokia as the anchor firm and housing more than 30 major suppliers coordinated by logistics agents. The cluster specializes in GSM mobile-phone manufacturing—a technology that has already matured, and is suitable for latecomer mass production. But it is highly significant that Nokia chooses to use a clustered approach to securing its mobile-phones in China in just-in-time fashion, rather than seeking to do it all on its own. According to the authors of a study of Xingwang, Henry Wai-chung Yeung and Weidong Liu together with Peter Dicken (2006), the early success of Xingwang industrial cluster owes much to its location and the facilities made available, but also to the investigations conducted by Nokia into the workings of strategic networks in the automotive industry (Nokia managers visited the automobile assembly complex created by Volkswagen in Barcelona, Spain, in 2000, to observe the workings of a sophisticated industrial cluster, and then applied the lessons in China.) Once Xingwang park goes into full production, it is expected to generate sales revenues of US$6 billion and provide employment to 25,000.

Much interest now attaches in China to the listing of the Top 100 industrial clusters, compiled each year by the Chinese Academy of Social Sciences. The most recent listing is shown graphically in Fig. 1 (created by the Li & Fung Research Centre in Hong Kong).[39]

[39] See 'Update on industrial clusters in China (2010)' by the Li & Fung Research Centre, Hong Kong, available at: http://www.lifunggroup.com/research/china_industrialcluster01.htm

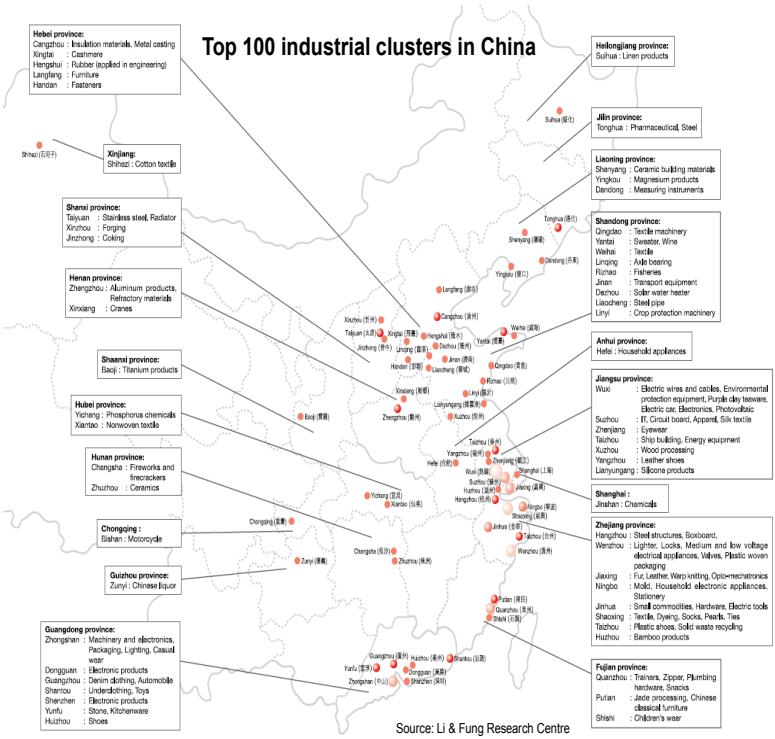

Figure 1

The 'gold standard' cluster created *de novo* in East Asia, and which remains the ideal that both China and India are striving for, is the Hsinchu Science Park in Taiwan. Although I have dealt many times with this highly successful innovation in my writings over the past decade and a half, the basic facts bear repetition. [40] Founded in 1980 (another 30-year anniversary in the world of clusters), on army surplus land located an hour's drive south of Taipei, the Hsinchu park was modelled initially on Taiwan's earlier experiences with very successful export processing zones in Kaohsiung and Taichung. But Hsinchu was to be a 'science park' in the sense that it was subject to a

[40] See for example Mathews (1997); Mathews and Cho (2000); Mathews (2001; 2002a; 2002b).

governing institutional authority that only allowed firms into the park if they met certain criteria (such as higher than normal levels of R&D expenditure) and in return for which they enjoyed considerable advantages, such as tax holidays for the first five years, and tax concessions on industrial upgrading initiatives. The park was deliberately located close to the main public R&D facility in Taiwan—the Industrial Technology Research Institute (ITRI)—as well as the campuses of the two leading technology-focused universities, National Chiaotung University and National Tsinghua University (both originating as Taiwan-based replicas of their Chinese originals, which at the time were just recovering from the difficulties of the Chinese Cultural Revolution). This combination has proven to be highly fortuitous, as companies attracted to the Hsinchu park have been able to count on the universities for supplies of skilled professional staff, while they have been stimulated by exposure to the technological innovations emanating from ITRI. These technological innovations were not new to the world, but they were certainly new to Taiwan—and in this sense ITRI acted as a powerful driver of technology diffusion within Taiwan (initially within the Hsinchu park) while acting as a powerful absorber (or leverage agent) of new technologies sourced from abroad. Indeed the process has been so successful, and so many firms have been clamouring to enter the park, that Hsinchu expanded its geographical limits (twice) until there was no more land available, and then a second such park in southern Taiwan (on land released by the national sugar monopoly) was opened—the Tainan science park—with a new emphasis on biotechnology, food and health sciences, as well as TFT-LCD flat panel displays. For good measure, ITRI opened a southern campus at Tainan as well. A third park in central Taiwan, the Taichung science park, has since opened as well. The three parks (covering around 3,700 hectares) constitute Taiwan's 'Silicon Island Project'.

As detailed in Chen (2008), the Hsinchu park was initially anything but a success. The first firms to locate there were not start-ups or multinationals, but Taiwan firms in the IT sector

(Acer and Mitac) that were sub-contractors for major IT firms. Over the first decade, IT and PC assembly firms dominated the park's population, and while enjoying agglomeration economies in the sense of a shared labour pool, shared utilities and shared infrastructure (not to mention tax advantages), they were not generating common scale or scope advantages through inter-dependence. But things changed rapidly in the second decade, in the 1990s, as the Taiwan government took active steps to promote the creation of a semiconductor industry, almost all of which was concentrated (large fabricators plus upstream IC design firms and suppliers) in Hsinchu. From a modest population of 121 companies in 1990, employing 22,356 employees and producing revenues of NT$65.6 billion, the park expanded rapidly in the second decade, numbering 369 firms in 2003, employing 101,763 employees, and generating revenues of NT$857.8 billion—a twelvefold expansion. During the second decade, the related industry of flat panel display fabrication, together with a rich supply chain of components and sub-systems producers, also located in Hsinchu—as well as in the second park in Tainan, where there was also an attempt to cluster firms in biotech, health and foodstuffs industries. In the 2000s one can see the solar photovoltaic (PV) industry emerging as a 'third pillar' of Taiwan's high-tech industrialization efforts. These industries have all been phenomenally successful, and clearly owe much to their clustering in Hsinchu, near to ITRI, to each other, and to the universities.[41]

To what extent has Hsinchu behaved like a 'cluster' with an emphasis on expanded output for the firms involved, and tight

[41]Chen (2008) provides a current account of Hsinchu's success as a purposively developed industrial cluster. For earlier insights, see Lee and Yang (2000) and Tsai and Wang (2005). Guerrieri and Pietrobelli (2006) include a prominent place for Hsinchu in their comparison between clusters in Taiwan and Italy, while Bresnahan, Gambardella and Saxenian (2001) include Hsinchu as one of their 'new' Silicon Valleys that generate 'social increasing returns'.

inter-linkages between the firms, with growing specialization for intermediaries emerging as the market expanded? The Hsinchu park has acted in the same way as a SEZ in China, in the sense that it now houses several clusters, focused on ICs, computers and peripherals, telecommunications, optoelectronics and flat panels, as well as precision machinery and, most recently, biotech.[42] All these clusters are developing a rich ecosystem of suppliers and customers (vertical supply chains) as well as horizontal linkages, together with major links to the global economy—both through contracts with leading global firms in these sectors, as well as direct export sales, and openness to return immigrants from Silicon Valley and elsewhere who bring back their skills and contacts to Hsinchu.[43] It is the variety of clusters within the Hsinchu regional agglomeration that surely accounts for the vibrancy of the region today. The remarkable build-up around Hsinchu of forward and backward linkages within the flat panel display cluster—forward to users of FPDs such as high-definition digital television producers, and backward linkages to key component suppliers, is shown in Fig. 2. This constellation of linkages stands as the key to cluster success, in Taiwan and elsewhere.

[42]In 2004, of total sales revenues of $NT1086 billion in the Hsinchu science park, 72% came from ICs, 12% from computers and peripherals, 11% from optoelectronics, 5% from telecomms, with the balance coming from precision machinery and biotech (Hsinchu Science Park Administration, annual statistics),

[43]Saxenian (2002) has emphasized the role played by Taiwan skilled immigrants in helping to build Silicon Valley—but of course in a reverse direction these same people have also given enormous benefits to Taiwan, and to Hsinchu in particular, which they have favoured as a location for their entrepreneurial start-ups — see also Hsu and Saxenian (2002) and Saxenian and Hsu (2002). Yang et al (2009), drawing on the global production network literature, label this as an instance of 'strategic coupling' between Hsinchu and the global economy.

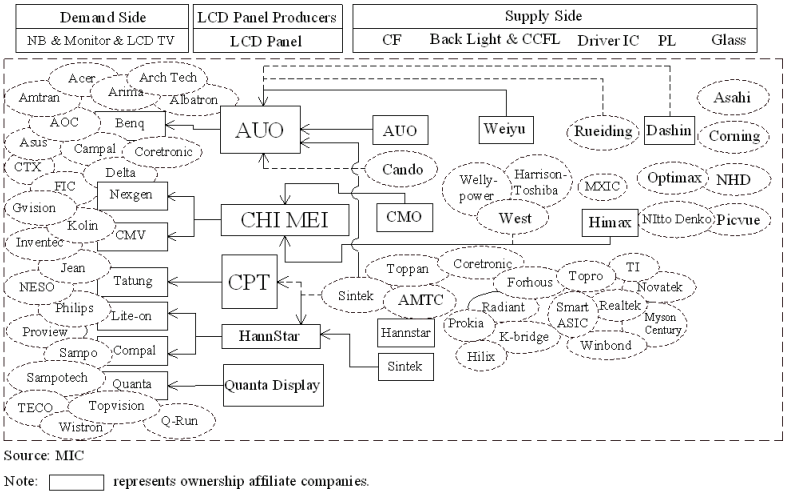

Figure 2 Taiwan FPDs: Rapid buildup of supply-side and demand-side firms

India: The rise of SEZs

China's success with SEZs and the industrial clusters they generate has not passed unnoticed. In particular, India has since been pursuing its own SEZ programs, at both a national and state level—with some remarkable successes as well as setbacks. India abandoned the old EPZ and FTZ models and embarked on a full-blown SEZ program in 2000, after the country's Industry Minister visited China's zones and saw for himself the changes they were unleashing. [44] The cluster

[44] Palit and Bhattacharjee (2008) provide an up to date account of the Indian SEZ phenomenon. The Indian scholar Aradhna Aggarwal, together with colleagues, has done much to bring these Indian initiatives to international attention; see Aggarwal et al (2009) and Aggarwal (2010) for recent studies, and Aggarwal (2006) for an earlier comparative study. An alternative approach to Indian industrial clusters focused on generation of technological capabilities is provided by Gulrajani (2006), while Knorringa (1999) treats a traditional cluster (Agra) adapting to new circumstances. Given the enormous success that China and now India are having with SEZs as driving institutional settings for creation of new industrial clusters, it is astonishing that in a recent survey of reports on industrial clusters worldwide, compiled

phenomenon in its modern guise in India dates from the last ten years, when SEZs have been pursued by both state and central governments, and in particular since the passage of the SEZ Act in 2005. Prior to this most recent decade, there were of course numerous clusters, but they tended to be traditional and largely spontaneous in nature—like the footwear cluster in Agra, described in Knorriga (1999). India has also had a long involvement with Export Processing Zones, seeing the first EPZ in Asia established in Kandla in 1965. But despite their multiplication on the subcontinent, they did not spark the anticipated industrial revolution, and India looked on while China benefited enormously from its Open Door and SEZ approach in the 1980s and 1990s. Since the visit of the Indian Minister of Industry to China, in 2000, to see the SEZs and the clusters they contained at first hand, there has been a decided change in strategy in India, and a marked uptick in the rate of cluster formation—with extremely beneficial results for Indian industry and the economy generally (and some distressing setbacks, as projects to set up industrial clusters run into cultural and social barriers that have deep roots in India).[45]

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by the German scholars Thomas Brenner and André Mühlig (2007), the authors provide a comprehensive review of 159 cases of industrial clusters discussed in the literature—and yet only four of these are from India (mostly traditional textile districts) and only one from China (an electronics cluster in Nanjing). Perhaps these authors overlooked so many clusters in China and India because they didn't think them sufficiently important, or perhaps it was simply an excess of Eurocentric zeal.

[45] For example, in September 2010 a petition has been taken to the Bombay High Court challenging the validity of the SEZ Act on the grounds that it empowers the government to take over land that had been used for agricultural purposes. The pity is that there have been all too many cases of farmers' dispossession, land grabs and real estate deals posing as industrial development initiatives. The petition is of course not informed by any insight into the process of industrialization, which everywhere moves from raising productivity in agriculture to establishing manufacturing industry on formerly agricultural land, with enormous improvements in incomes resulting. For details of the challenge, see 'Petition challenges SEZ Act' in Yahoo! News India, available at:

The Special Economic Zones Act was passed by the Indian parliament in May 2005, and it came into effect at the beginning of 2006, streamlining and simplifying the rules under which SEZs could be established, by state governments, by the private sector, and by the central government itself. In effect, the SEZ Act creates an industrial growth engine within the Indian economy. A large number of initiatives have been taken. Between 2000 and 2005 only 11 new SEZs were set up, but since the passage of the SEZ Act the pace of development has accelerated. By 2010 no fewer than 580 SEZs had been approved across 23 states, with 114 of these being operational and already reporting some degree of economic activity.[46] The growth rate is comparable to the expansion experienced in China in the early years of its promotion of SEZs:

Year	Value (Rs. Crore)	Growth Rate (over previous year)
2003-2004	13,854	39%
2004-2005	18,314	32%
2005-2006	22, 840	25%
2006-2007	34,615	52%
2007-2008	66,638	93%
2008-2009	99,689	50%
2009-2010	220,711	121%.[47]

The impact of the SEZs in certain sectors has been dramatic, particularly in terms of exports. The share of output from SEZs

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http://in.news.yahoo.com/20/20100923/1416/tnl-petition-challenges-sez-act.html

[46] See the website on SEZs maintained by India's Ministry of Commerce and Industry, at: http://www.sezindia.nic.in/about-asi.asp

[47] 1 Crore rupees = approx. US$4 million. So the export value produced by India's SEZs in 2009-10 was US$55 billion—or just over 5% of Indian GDP of US$1240. The jump in the figure for 2009/10 over 2008/09, of US$22 billion, is suspicious, and could reflect changes in definition of terms used.

in exports was around 5% in the years 2000 to 2005, but after the passage of the SEZ Act it has leapt to 11% in 2008/09, and no doubt much higher more recently. Investment has increased dramatically, from under US$1 billion in 2005 to $28.5 billion by the end of 2009—and employment growth has been equally remarkable, growing from 135,000 employed persons in 2005 to 490,000 by the end of 2009. SEZs have emerged in India as a means to promote industrial upgrading and diversification, driven by renewed openness to FDI. Indeed there are three generations of SEZs now operating in India simultaneously—a first generation involving low-tech, labour-intensive operations (such as Apache in Andhra Pradesh for footwear or Cheyyar in Tamil Nadu (in the south of the country); a second generation series of SEZs involving IT, auto components and electronic components; and third generation SEZs involving biotech, pharmaceuticals, petrochemicals and renewable energies (clean technology).

One of the key success stories of India's SEZs is the telecomms cluster located in **Sriperambudur** near Chennai (formerly Madras, in the south), widely known as India's answer to Shenzhen. This SEZ, initiated by the Korean multinational LG, now houses operations of several global firms and their supplier networks—such as Nokia. The Nokia cluster is a fast growing zone modelled on the success that Nokia has had with Xingwang in China. The initial commitment was made in 2006, and the zone now encompasses Nokia together with numerous suppliers which are already being formed into tier-1 and tier-2 suppliers. By 2010 it was employing over 18,000 staff, while the whole SEZ was employing in excess of 50,000. Three types of firms and operations are locating in Sriperambudur. There are OEMs like Nokia and Motorola. Then there are electronics contract firms like Flextronics and Foxconn, who supply OEMs around the world. And there are component suppliers who feed their products direct to the OEMs and electronic manufacturing service providers. A related Velankani SEZ is being established to house more of the key components suppliers, enhancing the integration of the manufacturing network. Much of the software

utilized by components firms in Sriperambudur comes from firms located in nearby Chennai, thus recreating the kind of complementarity that drove the success of Silicon Valley or has worked so well at Hsinchu Science park in Taiwan.Other SEZs are specializing in renewable energy industrial clusters and in clean technology generally. The Suzlon SEZs at **Coimbatore**, Vadodara, and Mangalore constitute a home-grown success story. Suzlon, founded in 1995, has been a spectacular success in the global wind generator manufacturing industry, climbing to reach 3rd position in the world table of producers, after only GE and Vestas. At Coimbatore, the second largest city in Tamil Nadu state in the south, Suzlon has established an integrated production facility housing companies producing the more than 20 separate components needed for a functioning wind turbine and its tower. Indeed, Suzlon has leveraged this success to set up other SEZs, creating a special subsidiary to cater to this market—Suzlon Infrastructure (now known as Synefra Engineering and Construction). It is further developing the SEZ at Coimbatore into a multi-purpose Hi-tech engineering zone, attracting Indian and global companies. Related projects are found at the Synefra Hi-tech SEZ at Vadodara (Gujarat state) and at Mangalore (in neighbouring Karnataka state on India's southwest coast).

A solar energy SEZ is emerging at the Moser Baer SEZ Udyog Vihar in Greater **Noida** (Uttar Pradesh state), founded in 2007. Moser Baer India is a success story in optoelectronics, founded in the 1980s as a joint venture with Maruzen Corporation of Japan and Moser Baer Sumiswald of Switzerland. At the end of the 1990s it entered the compact discs and recordable digital versatile discs (DVD-Rs) and in 2006 it announced its further diversification into solar photovoltaic (PV) as well as consumer electronics businesses. Moser Baer is specializing in thin film PV modules, transferring the technology from its optoelectronic activities. The SEZ is building complementarities, through firms locating there supplying gas to the thin film plant, and another producing solar cells.

Meanwhile Fab City in Hyderabad (Andhra Pradesh) is emerging as India's main hub for semiconductor fabrication activities, attracting firms that are diversifying into silicon-based solar cells such as Signet Solar, Titan Energy, Solar semiconductor and again Moser Baer. Fab City is being promoted actively by the state government of AP and by its industrial development agency, Andhra Pradesh Industrial Infrastructure Corporation (APIIC) as a means of kick-starting a chip fabrication industry in India with a latecomer focus on solar wafers and cells.[48]

In sum, the SEZs in China and India are demonstrating the power of clusters as a means of generating wealth, generating employment, attracting investment and engaging with the global economy—particularly in emerging sectors like clean tech and renewable energies. The success of the SEZ programs in these two major industrial powers, destined to be principal players in the 21st century, will doubtless spark emulation in other ambitious developing countries, such as Vietnam, The Philippines, countries in Central and South America, and eventually, of course, in Africa. It is time to turn to the strategic analysis of these SEZs and the other kinds of clusters that have been identified and analyzed to date, to see just how they work.

Strategic anatomy of networks

Let me now demonstrate how we can shed light on these issues of strategizing in networks by consideration of the fundamental categories involved, namely network resources, activities and routines, and how firms might strategize around these. These are the categories that are under direct management control, in the context of the individual firm. I wish to consider them not just at the level of the firm (as in Mathews (2006a; 2006b;

[48] As noted above, details on these high-tech Indian SEZs can be found in Aggarwal (2010), and for an historical overview, see Palit and Bhattacharjee (2008).

2010), but now at the higher level of the network or cluster. These categories enable us to formulate fundamental strategic goals for firms that are not derived from the mainstream economics discourse, and which are not derivable from the traditional production function.

Network resources: A resource-based view

The resources assembled by entrepreneurial action within a network are always more extensive than those available to any individual firm—this is the fundamental strategic reason for their formation (Gadde et al 2003; Eisenhardt & Schoonhaven 1996). The point of strategizing in this context is to *enlarge the scope of strategic options* available to the firm through entering into direct relations with others. The focus is on the pool of resources accessible by the firms in the network or cluster rather than on the resources available to any single firm. Thus in the biotech sector, for example, startup biotech firms build a business model around the packaging of new laboratory systems or infrastructures (e.g. for proteomics) based not on the long and laborious process of acquiring such resources or facilities themselves, but in forging networks of existing suppliers all of whom share a common goal in wishing to reorient their offerings towards a new biotech market. Consider Proteome Systems Ltd, a startup proteomics firm that in less than three years built a worldwide proteomics platform for sale to laboratories, drawing on existing suppliers such as Shimadzu and Thermo-Finnigan for mass spectrometers, on IBM Life Sciences for the bioinformatics, on Sigma-Aldrich for sample kits, and so on.[49] It is the global scale of the market that makes it feasible for a firm like Proteome Systems to act as orchestrator of several incumbents, each supplying an important component needed for a new proteomics laboratory platform, but none covering the system as a whole. Indeed it was the

[49]For further details of the PSL case, see Mathews and Carmen (2002) as well as Mathews and Zander (2007).

strategizing role of PSL to actually build this world-wide supply system where none existed before, drawing into the platform a series of firms providing complementary technologies.

Explanations for cluster formation and governance have come from the strategic management literature. Here the focus has been on matters such as how firms formulate and achieve strategic goals through the formation of consortia and networks; how firms and agencies combine to enhance their resource base; and how they can actually manage the complex processes of building inter-firm collaborative routines. These strategic goals include gaining access to technical capabilities not otherwise easily accessed, particularly complementary technological resources, which generate new business opportunities. One of the key aims is to collectively enhance the participant firms' *absorptive capacity*, thus giving them potential access to a wider range of technological options, and enlarging the scope for their collective organizational learning (Cohen and Levinthal 1990; Zahra & George 2002); indeed it makes sense to speak of the *absorptive capacity of the cluster as a whole*,

emphasizing that one of the essential features of cluster success must be openness to new ideas and techniques, requiring cluster-level routines for acquiring these external sources of knowledge.[50] In a latecomer setting, countries such as Taiwan have been able to utilize R&D consortia with the specific goal to promote the interests of small and medium-sized firms through the transfer and sharing of resources and the collective enhancement of absorptive capacity. Likewise for multinational corporations, the attractions of relocating operations in lower-cost countries are considerably enhanced when such operations can be located within nascent or developed clusters—to the

[50]See Giuliani (2005) as well as Vang and Asheim (2006) for interesting applications of the notion of absorptive capacity to the level of industrial cluster. Identifying the precise mechanisms through which the cluster's interfirm connections generate enhanced absorptive capacity remains as a challenge for scholars.

mutual advantage of the multinational and the host (developing) country (Manning 2008).

As in the Palm OS platform, or the Symbian platform, or indeed the Windows platform, the goal is to recruit as many firms bringing complementary resources to the network, thus extending its functionality and adaptability and making it more likely that the platform will be adopted by more and more users—a self-reinforcing and self-organizing process. The network thus depends on firms being willing and able to strategically make use of external resources (Jarillo 1989) and to engage in various kinds of resources exchange, recombination and reshuffling. The fundamental strategic goal associated with the assembling of resources in a network is thus the capture of *complementarities*, or synergies, that are expressed in terms of the resource bundle making up the entire network—a topic to which I turn in a moment.

Network activities: An activities-based view

The description of any network is given in terms of its activities, which are linked together in what may be described as an activity network, or what Porter calls an extensive value chain or Alderson called a transvection (as opposed to a single transaction). Whatever the terminology, the fundamental point (made by Porter and others) is that such value chains (activity networks) expand the capacities of any individual firm within the network, and they become the object of strategizing. They are not given by "economic forces" but are created, configured, and reconfigured by firms, as part of their strategizing behavior. The firms participating in such a network themselves strategize over their involvement—to be part of the network or not, and on what terms—while the firm initiating the network strategizes over its scale, its scope, its configuration, and within the chosen options then manages the logistics as if it were managing its own internal activities. The evolution of the inter-linked activities conducted by the firms that participate in the cluster, and their configuration, then becomes the prime object of

interest—rather than issues of allocative efficiency and fictional equilibria.

Firms strategize around their activities by reconfiguring their value chain(s), in the explicit pursuit of increasing returns. Consider the case of IKEA, long a favorite for such examples. The firm was founded by a young entrepreneur Ingvar Kamprad in the 1940s. By the year 2001 IKEA was a global force in furniture retailing and production, with sales of 10.4 billion Euro (US$9.6 billion), a total of 143 own stores in 22 countries (plus another 20 franchised stores) and a vast *value constellation* of over 2,000 suppliers providing the key intermediate products that IKEA put together into its famous self-assembly kits. How large is the "suction power" of this vast network in the final consumer market? In 2001, there were over 255 million visitors to IKEA stores, and they utilized 110 million catalogs in making purchases. The vast purchasing power assembled by IKEA is what drives the strategizing by the supplier firms, to "enrol" themselves in the IKEA network.[51] What drives the strategizing by IKEA itself is the platform leadership that enables it to extend its range beyond what any company on its own could expect to accomplish.[52]

The case of IKEA provides a perfect illustration of strategizing in the setting of industrial clusters, specifically of the configuration of the value chain as a vertically-integrated network. For each of the firms involved in the IKEA system, there are strategic calculations to be made. But for IKEA itself, quite different strategic calculations were called for. In the case of IKEA, the strategic initiative consists in thinking through the

[51] Ivarsson and Alvstam (2010) provide a recent study on how IKEA recruits supplier firms in China, and distributes work to them in a way that recalls the same principles followed by Li and Fung.

[52] I am using the phrase *platform leadership* in the sense given by Gawer and Cusumano (2002), namely strategizing around the attraction and capture of as many complementary firms as needed to create an industry 'platform' out of a given technology or organizational form.

possibilities of applying an outsourcing model to a traditional industry, namely furniture production. The entrepreneur, in this case Ingvar Kamprad, has the vision to rise above the multitude of bilateral relations to see a system, or a configuration, in which value can be created simply by making connections that were not previously in place. Thus a vast network of suppliers is conjured into existence, not out of any particular love for IKEA, but because the IKEA model has created such a surge of buying power that there is more than enough value to go around, and can be shared between these suppliers and the end supplier, namely IKEA itself.

By contrast we may consider the case of Wal-Mart, where it was precisely the opposite kinds of considerations that led to the firm's strategic reconfiguration of its value chain. Wal-Mart in particular has achieved dominance in its industry by squeezing efficiencies from a traditional process of retail distribution, taking out the wholesalers and even its own warehouses in favor of making direct connections between suppliers and its stores. It has been strategizing to vertically integrate the firms that previously supplied separate value-adding steps in its value chain, again with spectacular results. Thus, whether it is the creation of a more dispersed value chain, or a case of vertically integrating within the value chain, the results sought are *increasing returns*, as the object of the strategizing endeavor applied to the firm's activities.

The fundamental strategic goal associated with the organization of activities in networks is to create linkages—and the more, the better. Multiply-connected firms start to exhibit emergent network behavior—as discovered in large-scale networks by physicists such as Barabasi (2002). In economic terms we may translate the notion of multiple linkages into the capture of *increasing returns*. As firms specialize, so they create incentives for incumbents to outsource, which can result in the strategic creation of activities networks on a global scale. All of this strategizing is conducted, of course, without any regard to any putative (fictional) equilibrium position.

Network routines: A dynamic capabilities view

The routines that link firms' activities in their management of network relations are amongst the hardest to build and jointly manage. It is the capacity of firms to build and manage interorganizational routines that largely determines the success of their collaborative endeavors, as in joint ventures, strategic alliances, or in outright mergers and acquisitions. Learning at a collective level can be accomplished within all these kinds of structures; we may term this *economic learning* and link it to the population-level dynamics studied in evolutionary approaches to economics and organizations, and thus to *population-level learning*.[53] What emerges from this process is a set of population-level capabilities, or what Foss (1996) aptly called 'higher-order industrial capabilities'.

In the case of PSL again, each of the firms involved in supplying an essential part of the proteomics platform does so with its own established routines. Shimadzu has its routines for treating samples in a laboratory setting, and its business routines for billing and servicing customers. Sigma-Aldrich has its routines for supplying sample kits and again for billing customers. IBM Life Sciences has again established procedures for organizing proteomics data, and for providing access to it. All these routines need to be modified and coordinated to create smooth interfaces for the proteomics platform built and marketed by PSL worldwide. Indeed this is the "value-added" by a small, entrepreneurial startup like PSL: it consists in revealing to these incumbents how they can adapt their existing products to the needs of a new market segment, and providing a set of routines for doing so. The firms that aspire to "platform leadership" (Gawer and Cusumano 2002) where a set of standards form the core around which many firms congregate, need to be able to master the management of shared routines as

[53] The notion of population-level learning, or development of higher-order capabilities, has been explored by Miner and Haunschild (1995); and by Miner and Anderson (1999).

a core business proposition. This is in many ways the ultimate management frontier.

Cluster systemics

Within all the emergent suprafirm structures, and through the processes of industrial, technological and evolutionary dynamics that unfold within them, there is an overriding point of interest, namely the capture of "increasing returns" that emerge through the multiple interactions of the firms and any network institutions created for the purpose. Call them "spillovers" or "externalities" (as Marshall did) but they all refer to the "extra" that comes from multiple linkages and interaction, making the whole—a cluster, a platform, a development bloc, a technological system—more than the sum of its parts. The capture of increasing returns is far from being a simple or straightforward matter, and depends critically on the economy's institutional structures and processes—as the example of Okayama, to be discussed in a moment, demonstrates. But on the assumption that increasing returns can be captured, as an outcome of strategizing, the issue of how it is done must indeed loom large. It is all the more astonishing, then, to find that the issue of increasing returns has been almost entirely neglected in strategy, owing to the deadening assumption of "constant returns" being needed to close the general equilibrium system in economics (Buchanan and Yoon 1994; 1998).

Linked to the strategic goal of capture of increasing returns from activities is the capture of complementarities from the network's resources—a process that is again ignored in neoclassical economics, where resources are considered (at equilibrium) to be perfectly substitutable. But firms strategizing in network settings cannot afford to ignore complementarities; indeed they drive strategies of network formation and growth. And then within the network, resources need to be linked to activities via interfirm routines—whose management, again, presents itself as the strategic issue of building network

capabilities, or what Miner & Haunschild (1995) call population-level learning. Population-level learning occurs at a higher level of recursion than organizational learning, which in turn occurs at a higher level of recursion than individual learning—and at the higher level of recursion, many interesting emergent features can emerge—such as trust.

In these ways, then, we may pose the strategizing goals for firms as they connect and network with each other in various kinds of suprafirm structures—to capture resource complementarities, to capture increasing returns, and to build interfirm capabilities through improving interfirm routines. Let us now turn to examine how these overall strategic goals may be achieved.

Strategizing around network resources: Capturing complementarities

Cluster assets: Stocks and flows

In the mainstream economics literature, cluster externalities or agglomeration economies are simply defined as existing, without meaningful enquiry into their origins. Yet the strategic advantages for firms lie not so much in geographic proximity, as in complementarities of various sorts, which may or may not be generated by contiguous firms. Let us apply the notion of the capture of complementarities to the level of the resources held by a network, to see how strategizing might emerge. Adapting Dierickx and Cool (1989) to this case, I suggest that there can be up to four sources of competitive advantage generated by clusters, through the build-up of resource complementarities over time, grouped around asset mass efficiencies; asset stock interconnectedness; time compression diseconomies; and causal ambiguities. Dierickx and Cool applied these categories at the

level of single firm—but they make much more sense when applied at the level of the cluster.[54] These then provide an original, dynamic, resource-based account of the emergence of localized economies (Malmberg and Maskell 2002).

Asset mass efficiencies: Like an incumbent firm, an existing cluster builds advantages in terms of the scale and scope of its resources and routines that can be assimilated and expanded. Dierickx & Cool meant by this term that a single firm that possesses a stock of resources (assets) will be able to extend this stock preferentially over a firm that starts without it—a rather simplistic idea built on the notion of economies of scope. But applied at the level of collective resources belonging to a cluster, the notion comes into its own. The clustering process itself expands the resource base through specialization—and specialization then in turn expands the market for the products or services produced by the cluster. This is a powerful 'circular and cumulative process of causation' operating within clusters that has no counterpart at the level of the individual firm. At a more prosaic level, a cluster can focus its strategic attention on some particular asset mass such as a dominant technology, allowing member firms to focus their activities and adapt their routines to this common asset; this would be a dangerous strategic choice for a firm on its own, but if a whole cluster makes the choice (as many do in China or Taiwan, for example) then the risks are moderated. The stock of resources and collaborative routines circulating within an existing cluster can

[54] The discussion of cluster-level attributes such as asset mass efficiencies and asset stock interconnectedness opens the door to similar discussion of other cluster-level analogues of concepts previously framed at the level of the firm—such as absorptive capacity—and even at the level of the individual—such as self-efficacy. Indeed it makes eminent sense to talk of cluster-level absorptive capacity (cf Giuliani 2005, and Vang and Asheim 2006) or cluster-level self-efficacy, since this provides a means of focusing attention on the self-acting interfirm processes involved in generating knowledge spillovers, and on the action orientation needed if real clusters are to identify themselves as such and turn their potential into actual advantages. This remains an area awaiting exploration.

be captured in the notion of 'social capital' and it constitutes a powerful source of advantage, both in opening up opportunities for new firms within the cluster (with a ready local market for specialization) and in providing a sense of social discipline, and underwriting collective intangible assets such as trust (Maskell 2001) and capacity for cognitive coordination (Foss and Lorenzen 2002; Lorenzen and Foss 2002). Essentially, the more that a cluster builds such a stock of collective assets, the more it is able to create and extend assets based on these, to further secure advantages.

Asset stock interconnectedness. Resource complementarities act as a powerful social 'glue' in existing clusters. The more resources that can be assembled, the more their complementarities can be exploited and specialization opportunities generated—as in platforms like that built on the Palm OS and the specialized applications that developers build for it. The more resource specialization exists in a cluster, the more opportunities there will be for specialized firms to make new connections and linkages, enabling the market served by the cluster to grow, and thus feeding back on the further specialization induced. As the market expands, some firms can specialize in intermediate subassemblies, to create more complex value-adding pathways within the industry. Standardization of subassembly modules enables potential economies of scale to be captured, and an organizational reconfiguration of resources to be effected. It is the possibility of intermediate specialist activities emerging, as the scale of the market expands, that drives specialization of resources. This is what Marshall was getting at with his comment that the secrets of industry are 'in the air' in a cluster, and account for the emergence of a Marshallian industrial district as discussed in the literature on Italian districts and their competitive dynamics. Every successful cluster utilizes this fact of interconnectedness; without interdependencies, the firms in the cluster have little incentive to work together and to pool resources, and capture no more than agglomeration economies.

Time compression diseconomies. The fundamental advantage of the cluster or network lies in path dependence and accumulated linkages, that once started are hard to reverse, and very hard to imitate *by a rival cluster*. The pattern of linkages generated in a large network will become irreversible and extremely difficult to emulate. Thus while it may be argued that time compression diseconomies can be reversed by challenger firms (when they enter an industry coinciding with a major shift in platform technology for example), it remains the case that such economies work to the advantage of established clusters. Experience around the world shows that, in spite of repeated and determined attempts to do so, it is very hard for new regions to replicate what has already been accomplished in Silicon Valley, say, or the Boston area, or Cambridge in the UK. The same claim may be made for a platform like the Palm OS or the Symbian platform for smart phones: these generate so many linkages through complementarities that they become extremely hard to imitate—a phenomenon captured in static terms by economists as network effects. It might be difficult but it is not impossible—as evidenced by the hundreds of industrial clusters now being formed in China and India within the institutional setting of Special Economic Zones. Frequently these clusters are formed at the instigation of flagship firms in global value chains, and through such processes the time compression diseconomies can be overcome.

Causal ambiguities. While causal ambiguity at the level of the firm can be overcome by challengers through securing access to explicitly codified knowledge and modular components, in the case of the cluster the sources of success are clouded in social processes such as norms of conduct and patterns of assimilation and affiliation that can be hard for nascent clusters to imitate. A cluster can take a long time to develop, through complex and largely fortuitous processes of interfirm dynamics. But this does not mean that causal ambiguities cannot be countered with purposeful policies designed to facilitate or accelerate cluster formation—as evidenced in Singapore, for example, where clusters based on semiconductors and electronics, on precision

engineering, on marine engineering, and on petrochemicals, have been created through purposeful policy, or in Taiwan, where a semiconductor and ICT cluster has been created around Hsinchu science Park, as described above. Always the key to these efforts lies in creating the conditions in which interfirm connections can be multiplied and where institutional sources of knowledge generation can be created—thus replicating, in a small way, the marvelous interconnectivity of the human brain.

Strategizing around network activities: Capturing systemic increasing returns

Network increasing returns may be described as "systemic" in order to distinguish them from the increasing returns sought by firms through the reconfiguration of their individual value chains internal to the firm. The point is that multiple connections and linkages constitute the source for the increasing returns—just as in the case of a multiply-connected set of neural pathways that we call a brain. Marshall was groping for this, in his concept of *externalities*, but he was hobbled by his commitment to the notion of the "representative" firm. The category of increasing returns is an emergent property of closely connected systems; such returns can be captured at multiple levels of recursion, from the level of the firm, to that of networks, to that of the economy as a whole. In the economy, they emerge through the process of specialization, that expands linkages and drives cluster formation. And formation of clusters in turn accelerates the processes of specialization as the market created by the cluster in its immediate vicinity expands—a process best captured in the phrase 'circular and cumulative causation'.[55]

[55]The phrase 'circular and cumulative causation' (C&CC) was first used to describe the cumulative and one-cause-feeding-off-another character of economic development by the Swedish economist Gunnar Myrdal, in his

Intermediation and disintermediation in networks and clusters

Networks, clusters, platforms and development blocs are the linked structures through which the economy generates increasing returns, over and above the returns available to individual firms through their own strategizing efforts. Marshall categorized these as *internal returns* captured by the firm through its own internal organizational efforts (and subject according to the conventional wisdom to diminishing returns) and *external returns*, arising from the activities of others and not subject to diminishing returns. Such structures emerge through the process of *specialization*, which as Adam Smith acutely observed, is the key to social productivity enhancement. Enhanced performance at the economic level, as at the organizational level, can be captured through specialization and the emergence of intermediate input suppliers, which in turn is associated with decomposing a process into a finer division of labor. Consider the case of a group of firms, each specializing

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1957 text, *Economic Theory and Under-Developed Regions*. The brilliant economic theorist Nicholas Kaldor picked up the idea of C&CC from Myrdal, when they both worked at the UN Economic Commission for Europe, and he took it over as one of his central categories. In his 1970 work, in a sub-section entitled The principle of cumulative causation, Kaldor wrote:

> […] what Myrdal called the principle of 'circular and cumulative causation' […] is nothing else but the existence of increasing returns to scale […]' 1970/1978: 143.

Elsewhere Kaldor wrote that 'with increasing returns change becomes progressive and propagates itself in a cumulative way. Myrdal […] called this the 'principle of circular and cumulative causation' (1972/78: 186). Toner (2000) provides what I believe is the only book-length account of the intellectual trajectory of C&CC, from Allyn Young to Myrdal via Rosenstein-Rodan and Hirschman to Kaldor and beyond. Toner (2001), Argyrous (2001) and Setterfield (2001) provide an interesting exchange on the relevance of C&CC reasoning in the *Cambridge Journal of Economics*. But there the matter seems to rest; the phrasing C&CC has yet to be taken up by theorists of clusters, networks or economic geographers.

in a particular range of products and overlapping with each other in terms of their resources and routines. As the market expands, some firms can specialize in intermediate subassemblies, to create more complex value-adding pathways within the industry. Standardization of subassembly modules enables potential economies of scale to be captured, and an organizational reconfiguration of resources to be effected through strategic intervention. It is the possibility of intermediate specialist activities emerging, as the scale of the market expands, that drives the strategy of specialization. If these activities are conducted by new, specialist firms, creating a spread of pathways, it is a case of horizontal division of labor (Langlois 1991; 2007). If the activities are conducted within the same value chain, it is a case of vertical division of labor (Stigler 1951). With both horizontal and vertical division of labor (or specialization) occurring, rich, multiply-connected networks can be created.

Or are they? There are two kinds of counter-cases to consider. In the first place, sometimes the required further specialization is not achieved, and the economic performance of a group of firms is thereby degraded. This has occurred over and over again as industrial districts wax and wane. The district of Okayama, in western Japan, for example, provides a striking case. It became a flourishing center of production of varied kinds of farm engines in the 1950s and 1960s as Japan's farmers moved en mass to mechanize their operations. They needed one engine only per farm, to drive pumps, tractors, or threshing machines. Over 30 manufacturing firms arose in the Okayama district to service this need, producing small, light engines of variable but low horse-power to a variety of end-specifications, for distribution by specialized distributors throughout Japan. But nothing remains of this district today. It was wiped out by the rise of mass producing firms that were much more vertically integrated and connected to lengthy subcontracting chains than were the small Okayama producers who encapsulated all the technical capabilities needed to produce an engine in one small firm. As new kinds of engines appeared, such as faster and

lighter machines, the small self-contained producers of Okayama found themselves unable to switch from being self-sufficient producers to specialized parts of a longer production chain. The longer metropolitan production chains, which encouraged specialized mass producers, therefore wiped them out.[56] From the strategizing perspective, these Okayama producers were not able to make the breakthrough, *as a group*, from self-sufficiency in resources and activities to a new configuration where some resources are shared between firms. There was apparently no institutional mechanism in this case to shift the cluster of firms to a new configuration. Successful clusters of firms, such as in a Silicon Valley, are able to make these configuration shifts; others stay "locked in" to a particular configuration and decline. The issue is how such shifts are accomplished, and whether they call for specific institutional interventions, or are accomplished by the actors themselves.

In the second case, there might be a counter-tendency that promotes vertical integration, and horizontal integration, in place of vertical and horizontal specialization. Far from being far-fetched, this is actually what Chandler (1992) argues was the *dominant trend*, for the 100 years from 1850 to 1950. This was the trend that resulted in the creation of the giant, Chandlerian firms. They responded to the expansion of the market not with a further deepening of the division of labor, but with further integration, enfolding operations within themselves to keep control of coordination of activities in managerial hands. In Chandler's memorable phrase, this was the "visible hand" of management taking over from the invisible hand of the market. Chandlerian firms responded to the increasing scale of the market by investing first in large-scale manufacturing, to

[56]See Tokumaru (2003) for an account of the Okayama experience. Similar starting points were encountered in the Komatsu cluster (earth-moving equipment) and Ota cluster (automotive parts) but these did develop into important industrial clusters, based on complementarities and linkages—see Yamawaki (2002).

enable them to capture economies of scale and drive down costs; then in large-scale marketing and development of wholly-owned distribution systems, in placed of entrusting their output to merchants and wholesalers; and then in large management hierarchies to coordinate the scale and scope of the expanded enterprise. So which trend predominates?

Evolutionary dynamics: Adam Smith (and Stigler and Richardson) vs. Alfred Chandler (and Lazonick)

We have two perfectly well reasoned and plausible trends operating as the scale of markets expand. On the one hand, Adam Smith predicts that the division of labor will deepen—a position strongly supported by George Stigler (1951) and by George Richardson (1972; 1996; 2002).[57] On the other hand, Alfred Chandler predicts that an expanding market will encourage firms to expand the scale and scope of their operations and take over tasks previously coordinated via the market a position strongly endorsed by Lazonick (2002). Which one is right?

The answer must be that both are right. Both tendencies coexist, and at any point in time one will be predominating over the other. As the scale of the U.S. market expanded, so it was true,

[57]As expressed by Richardson (1996/1998: 168): "where the scale of an economic activity increases, it will be practicable for component processes within it to be separated out. In general, the cost savings made available by an increase in the scale of a particular economic activity [lead] ... to a change in industrial structure, those stages exhibiting the greatest scale economies becoming the business of specialist suppliers." As expressed by Stigler (1951): “With the growth of industries, specialization of firms may take the form of dealing with a narrow range of products as well as performing fewer functions on the same range of products. .. When the industry has attained a certain size and prospects, many … tasks are sufficiently important to be turned over to specialists. It becomes profitable for other firms to supply equipment and raw material, to undertake the marketing of the product and the utilization of by-products, and even to train labor.” (1951: 189-90)

as Chandler argues, that firms responded more efficiently to the new opportunities by building gigantic activity and resource structures that could only be coordinated directly by specially constructed routines that required management hierarchies for their administration. But as one industry after another finds itself becoming globalized, we now see the opposite tendency asserting itself. In a world market, in electronics for example, there are sufficient opportunities for smaller, specialist producers to carve out a niche for themselves—and as they do so, it becomes efficient for large incumbents to outsource more of their operations to these specialists. So the Smithian process proceeds in our own time, creating new clusters and global value chains, and capturing increasing returns from specialization as it does so. Kaldor (1972) hit on the happy phrase *chain reaction* to describe this process. It has no counterpart in neoclassical economics—which is why Kaldor was one of the earliest and most articulate of the economists calling for rejection of the restrictive assumptions associated with the standard view of equilibrium-based economics.

Strategizing around interfirm routines: Building higher-order network capabilities

If a cluster strongly resembles a brain, then its acquisition of collective capabilities strongly resembles learning. The key to successful cluster formation, or development bloc creation, with all the economic prosperity that it can generate, is a process of institutional learning through which a group of firms can mutually reinforce each others' actions and lift themselves collectively to a higher level of performance. The key is institutional learning, to facilitate successful specialized intermediation, and avoid an 'Okayama outcome' where such specialization fails to take place. By focusing on this process, I bring into view the sets of routines that link one firm with another in the cluster, and how the repetitive operation of these routines, binding firms more closely together, results in an

emergent property that might be called "economic learning." Routines now operate collectively (such as R&D collaboration procedures, or venture capital routines for early-stage firm financing, or the patenting and patent licensing routines available through specialist law firms and patent attorneys in Silicon Valley), to sustain and enlarge the complementarities of resources and the increasing returns captured from interlinked activities.

Transaction costs for firms interacting with each other within the cluster can be drastically reduced through the development of such rules, or interfirm routines—as in the development of truncated contracts that leave out all the background clauses needed by firms that do not have the repeated close relations that obtain between firms within a cluster. As the routines are developed, improved and perfected, so we may describe the firms making up the cluster as developing cluster-level capabilities, or what Foss (1996) calls 'higher-order industrial capabilities' to distinguish them from the capabilities developed by firms individually. Just as Winter (2003) sought to categorize firm-level capabilities into first-, second- and higher-order competences, each one successively encompassing a greater range of applications, so we might do the same for cluster-level capabilities. As the interfirm routines are improved, so the cluster enhances its collective absorptive capacity and population-level learning, all based on knowledge spillovers.

How firms that are inter-connected manage to coordinate their activities, in the absence of a single 'headquarters firm' issuing instructions, remains a topic of intense interest. Essentially, as firms master the forms of coordination, they build inter-firm routines that embody what may be described as cluster-level competences, or in a wider sense, capabilities. If firm A in a cluster receives an order from firm X outside the cluster, and in order to take advantage of specialized skills within the cluster farms out parts of the order to cluster firms B, C and D (who in turn may farm out parts of their orders to firms E, F and G),

then the contracting itself provides the prime means of coordinating their activities. But what kinds of contracts would be suitable? One strategic choice would be cost-plus contracting, whereby firms B, C and D bill firm A with their costs plus a mark-up, thereby avoiding any sense that they are gouging firm A for profits at its expense, they will expect to be able to farm out work on the same contractual basis when they receive orders from external firms at some point in the future. When fulfilling the order from A requires firm B, say, to invest in some specialized equipment, or to take on extra skilled labour, then this is done on the basis of a mutual understanding that there will be further such contracts in the future. In this way the firms in the cluster avoid the kinds of opportunism and self-interest that dominate discussion in transaction cost economics (Williamson 1985). Out of these repeated episodes of mutual contracting we may say that the firms build and improve interfirm routines, and build trust—and on both counts, build competitive advantages over firms that do not enjoy membership of an expanding cluster. If a particular firm Z engages in forms of behaviour that go against these norms, then the cluster has a credible response—namely expulsion. This penalty can and must be used to maintain cluster integrity. In this way, the cluster as a whole may be described as building 'higher order' capabilities, or population-level learning.[58]

[58]It is striking that the literature on the 'knowledge-based theory of the cluster' inspired largely by Nordic scholars (e.g. Maskell 1998; - 2001; Lorenzen 2001; Malmberg and Maskell (2002); Maskell and Lorenzen 2004; Foss and Lorenzen 2002; Lorenzen and Foss 2002) emphasizes intangibles like the building of trust and the development of cognitive coordination, as an alternative to coordination based on tangibles such as contracts and economic incentives. My personal view is that this line of work would benefit from sustained confrontation with unorthodox economic concepts such as circular and cumulative causation and with systemic notions like synergies and increasing returns, or at the most basic level with such notions as cost-plus contractual routines. But its emphasis on the issue as to how firms within a cluster manage to coordinate their activities remains fundamental.

The concept of *economic learning* refers to a process through which an economy adapts to new circumstances using measures that go beyond random, price-guided reactions. Learning involves adapting intelligently to new circumstances by developing a repertoire of routines that are stored in memory and which can be drawn on as circumstances change. Examples of such economic learning routines would include firms learning to work collaboratively in R&D consortia to accelerate the process of new product development, or firms cooperating in export consortia, or public sector research institutes taking a lead in a new technology and diffusing the fruits of its development efforts across to constituent firms. In their influential article, Miner and Haunschild (1995) characterize as *population-level learning* the kind of institutional borrowing that goes on in such settings. They use the case of R&D consortia, and the U.S. case of Sematech in particular (as discussed above under R&D consortia). Population learning is clearly linked to the notion of collective absorptive capacity, and both are linked to the idea of knowledge spillovers.

It is worth drawing attention to the striking analogy between the well-connected economy (inter-firm connectivity) where higher-order capabilities are generated through repeated interactions, and the human brain. Consider Fig 4, which shows a set of human neurons. The essence of this picture is the interconnected character of the cell. Indeed a picture of the developing human brain reveals neurons in a frantic scramble to make connections; those that succeed (through capturing some kind of neural pathway initiated from external stimuli) are able to live and flourish, while those that fail to make connections, die.

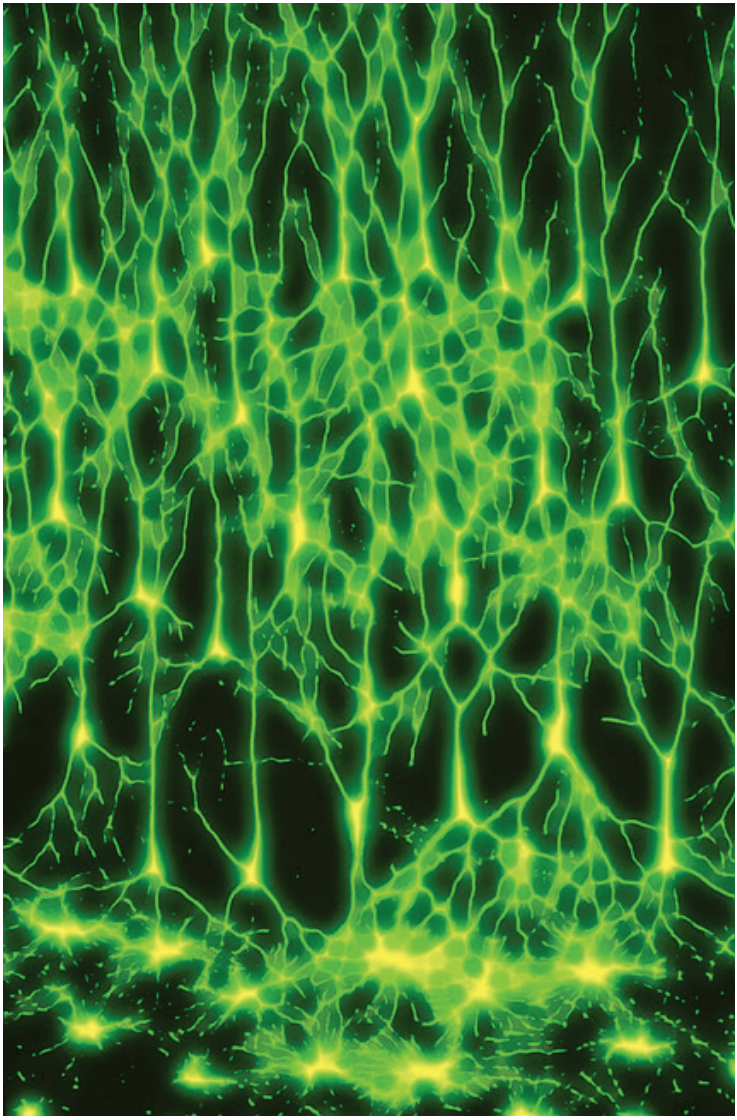

Fig. 4 -- Neuronal interconnections

Source: http://www.sciencephoto.com/

The resulting brain is a powerful organ that differentiates humans from all other products of biological evolution. Rather

than talking of perhaps thousands of elements, with tens of thousands of connections—as in the case of the economy—we talk in the case of the brain of upwards of 100 million neurons, making over *100 billion* connections with each other. It is *inter-neuronal connections* that drive brain performance—which we experience in terms of thoughts, volitions and consciousness. In the development of the individual person, it is now suggested that the nervous system and brain develops along Darwinian lines (or through the operation of what Calvin calls a neural "Darwin machine") and that thoughts too are the product of a Darwinian selection mechanism, where a number of alternatives (represented by alternative neural pathways) are presented, and a single pathway is selected.[59] Thus we may think of thought itself as a Darwinian process of generation of varieties of inter-neuronal connections, and selection of the pattern best adapted to the occasion.

The parallels between this process and the economy are manifest.[60] Firms likewise *strive to build connections with each other*, not through neuronal synapses, but through the device of *contractual relations* of one kind or another. The contracts governing these relations can be extensive, with many clauses, or they can be as simple as an expectation of mutual obligations and repeat business. But in all cases, the firms acquire something of each other's identity through the contractual encounter—a glimpse of each other's resource base, or routines or activity structures. Just as we "select" our thoughts in a Darwinian process, so we may view the "market process" through which firms adjust their operations, as a fast-motion Darwinian process.[61] The economic analog of consciousness is

[59] See Calvin (1996) for an overview of this perspective.

[60] Garud and Kotha (1994) likewise use the brain as a metaphor for flexible manufacturing systems, and at the same time provide an enlightened discussion of the use of such metaphors.

[61] Here I am emphasizing evolutionary (Darwinian) processes in market systems that move at a different pace from those associated with changes to "sticky" routines, resources or activities systems. This remains a new

the *increasing returns* or *added value* generated through interconnectedness between firms in the wider economy—or what I am choosing to call here the systemic gains arising from interconnectedness, and the higher-order industrial capabilities they represent. The more interconnected the economy, the greater its capacity to generate variety, and to promote innovation and economic learning. A poorly connected economy, where firms stand in splendid isolation from each other, has the appearance of a desert. It is unlikely that firms in such an economy will flourish.

We now turn to consider just how these various strategic perspectives on clusters and networks arise, and how they generate 'strategic opportunities' for entrepreneurial firms.[62]

Marshallian and Schumpeterian evolutionary dynamics of industrial clusters

The first real attempt to provide evolutionary theorizing to the economy was employed by Alfred Marshall, in his studies of industrial districts and their emergence in Britain in the 19th century. In particular, Marshall was concerned with the metals cluster in the Sheffield industrial district, where he conducted field work over the half-decade 1885-1890, resulting in a celebrated chapter on economic location in the first edition of his masterwork, *Principles of Economics*, in 1890.[63] This work

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territory to explore for evolutionary economics.

[62]Denrell, Fang and Winter (2003) introduced the idea of 'strategic opportunity' but in my view unnecessarily restricted the term to situations linked to optimization considerations. In Mathews (2006; 2010) I argue that the term should have a wider applicability in settings of disequilibrium, and now I do so again in the setting of industrial clusters.

[63]See Marshall 1890 and its subsequent many editions. The chapter on localization is Book IV.X *Industrial Organization (Continued) The*

stands at the very origins of our understanding as to how clusters work, and remains of continuing relevance for the acuity of Marshall's insights. Marshall identified three sources for what he described as the localisation of an industry, namely the capacity of firms to call on a common pool of skilled labour; the economies resulting from interdependencies between firms; and the knowledge spillovers generated. In modern parlance, we would characterize these as the sources for the competitiveness of an industrial district—and bear in mind that in 1890, Sheffield was at the very zenith of its wealth and its emergence as a 'growth pole' for British manufacturing industry.

So important have these three sources of competitiveness for an industrial cluster become that we know them now as 'Marshall's trinity'. It is worth starting this section by quoting Marshall himself on these three fundamental sources of localised competitiveness.

1) *Pool of skilled labour*

   'The leadership in a special industry, which a district derives from an industrial atmosphere, such as that of Sheffield or Solingen, has shown more vitality than might have seemed probable in view of the incessant changes in technique. The explanation is perhaps to be found in the fact that an established centre of specialized skill …' (Marshall 1919: 190)[64]

Concentration of Specialized Industries in Particular Localities.The eighth edition containing this chapter is now available online, at: http://www.econlib.org/library/Marshall/marP.html

[64] See Marshall 1919, *Industry and Trade*. This text too is now available online, through McMaster University, at: *socserv.mcmaster.ca/~econ/ugcm/3ll3/marshall/Industry%26 Trade.pdf*

2) *Local supplier linkages (forward and backward)*

   'Many cutlery firms [in Sheffield] for instance put out grinding and other parts of their work, at piece-work prices, to working men who rent the steam power which they require, either from the firm from whom they take their contract or from someone else …' (Marshall 1890: 296)

3) *Local knowledge spillovers*

   'Sheffield and Solingen have acquired industrial "atmospheres" of their own; which yield gratis to the manufacturers of cutlery great advantages, that are not easily to be had elsewhere: and an atmosphere cannot be moved.' (Marshall 1919: 176)

What did Marshall mean by these three emergent features? First, as firms co-locate and specialize in the same activity (or 'trade' in Marshall's terminology), they would exchange skilled workers and thereby create a pool of skilled labour that all firms could draw on. The specialization of activities within the cluster, and their underlying resources, creates the pool of skilled labour, and the existence of the pool of skilled labour thereby attracts further firms and further specialization—thus launching the cumulative processes (or 'chain reaction') observed in successful clusters.

Second, local specialized firms create external economies in the form of lower transport and logistics costs, lower communications costs, and (to the extent that utilities are shared) lower infrastructure costs. This may be described in terms of co-evolution of firms, their specialized suppliers and specialized institutions (or what Lane (2002) calls the 'scaffolding' of the network). Richardson (2002) captured this idea in the form of the expanding market creating opportunities for specialized intermediaries appearing—and as they grow and form linkages, so they create further opportunities for specialization and market expansion, in a cumulative process.

Third, local knowledge spillovers enable firms in the cluster to tap into the latest market intelligence, new designs, new markets, new technologies; this is what Marshall meant by stating that in an industrial district, the 'secrets of the trade are 'in the air' … We could give a more recent version of this phrase by saying that the cluster generates a 'buzz'.[65] In this way Marshall was actually the first to develop a 'knowledge-based theory' of the cluster, in the sense that he saw knowledge spillovers as fundamental—the knowledge being 'in the air' in a cluster.[66] But this has to be linked with an economic account of the lower costs enjoyed by firms within the cluster—their capacity to draw external economies from the cluster, and thereby generate the increasing returns that were clearly evident at the cluster level. This is the classic Smith-Marshall-Young argument that has its grounding in the evolutionary dynamics of clusters.[67]

But there is clearly another side to all of this. While specialized labour works to the advantage of a cluster in its expansionist phase, continued dependence on such specializations will tend to lock-in a cluster to a declining set of products and activities, and in the absence of other interventions, make it harder for the firms in the cluster to start new lines of development. Thus the specialized pool of labour can turn into a constraint that locks all firms into a declining market. Likewise the network of

[65]Or we could use the phrase introduced by Malmberg et al (1996), namely 'agglomeration forces' which drive firms to seek the advantages that are generated from clustering.

[66]This knowledge theory of clusters has been taken up and elaborated by a number of scholars, notably Scandinavian scholars Maskell, Lorenzen, Malmberg, Sölvell, Zander and Foss. In this work, the issue is posed fundamentally as the lowering of transactions costs through the building of trust, which in turn depends on the emergence of 'cognitive coordination' (Foss and Lorenzen 2002; Lorenzen and Foss 2002).

[67]Of course the identification of sources of agglomeration economies did not stop with Marshall's trinity—important as these are. Porter (2000) draws attention to other factors including local demand conditions and cluster interdependencies that are also important.

specialized firms can lock each other into a specific set of products and activities and make it hard to break out into something new. And the secrets that are 'in the air' (the higher-order capabilities) can become locked-in to a particular field of knowledge, thereby excluding other fields from intruding.

Far from this being a rare kind of development, with evolution (growth and expansion) becoming a process of involution (decline and lock-in), it is in fact the fate that awaits most clusters unless they take active steps to seed multiple lines of development, or (what amounts to the same thing) take steps to forge connections between one cluster and another, so that the two become the core of a self-generated network that can expand and encompass other clusters, at a higher level of recursion—at the level of a town, or city.[68] Thus Sheffield itself, where Marshall did his pioneering field work, has in subsequent years declined to become one of the poorest regions in Europe—and the reason must be that it allowed itself to become locked-in to an overly narrow set of skills, activities and products. The regions that continue to thrive—such as Silicon Valley, or Hsinchu in Taiwan—do so demonstrably through their capacity to seed new lines of development, and create a dense network of interdependent firms located within interdependent value chains, or transvections.[69]

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[68] In a striking study, the British economic geographers Antony Potter and H. Doug Watts (2010) have replicated Marshall's own field studies in Sheffield, but 120 years later, when Sheffield and its surrounding area is now classified by the EU as one of the poorest regions in Europe and one requiring Community assistance. They demonstrate how the very factors that helped Sheffield to expand in the 1880s and 1890s (Marshall's trinity) now work in the reverse direction to lock the region into outmoded economic activities.

[69] The discussion above concerning the rival Chinese clusters based in the Pearl River Delta (PRD: with lead cities Guangzhou, Shenzhen and Hong Kong) and the Yangtze River Delta (YRD: with lead city Shanghai) turn on precisely this point. A town in the PRD like Dongguan has the appearance of a high-tech centre, with its strong clustering of IT firms

So Marshall's sources of local external economies can work against a cluster as much as for it, in the absence of equilibrium-destroying innovations and entrepreneurial ventures that initiate new lines of development. This was of course the province of Schumpeter, who remains the 20th century economist of most relevance to China, India and other emerging industrial giants, precisely because he insisted on a view of the economy that focused on the seeds of new developments and their creation, rather than on what already existed.[70] A modern evolutionary perspective would see Marshall as the champion of evolutionary gradualism, and Schumpeter as the champion of saltationism—and a way of bridging the two perspectives being found in the framework of 'punctuated equilibrium', where populations of firms are viewed as existing for long periods in a relatively stable state (subject to incessant adaptation and learning) broken by occasional bouts of rapid, discontinuous change (caused, for example, by the arrival of a new technology, or a new flagship global firm) that forces complex reconfiguration of existing activity networks.[71] Depending on

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producing or contracting towards desktop computers. But when contrasted with Suzhou in the YRD, where the next stage of PCs—namely laptop computers—is clustering, then Dongguan appears to be at an evolutionary standstill. In the absence of determined intervention by the provincial Guangdong authorities, to force upgrading of Dongguan firms (which also calls for collaboration with global PC flagship firms like Acer) then Dongguan is destined to follow the path of Sheffield.

[70] The Danish economist Esben Sloth Andersen provides an authoritative exposition of Schumpeter's oeuvre, culminating in the publication of his 2009 work, *Schumpeter's Evolutionary Economics: A Theoretical, Historical and Statistical Analysis of the Engine of Capitalism.* Andersen touched on Marshall's evolutionary account of localized economies (clusters) in a much earlier paper in 1996.

[71] Antonelli (2007) provides just such a perspective, in a way that invites concrete empirical investigation of actual cluster trajectories and their punctuated equilibria. Gould and Eldredge introduced the notion of punctuated equilibrium (1977) and it is now widely accepted in the biological sciences—while its application in the social and management sciences remains fragmentary, in spite of some landmarks attempts at

the results of the punctuated disturbance, and its source as external or internal to the cluster, the cluster may be driven in a continuation of its existing trajectory or pathway, or to break with it and start a new line of development.[72] Applications of such a perspective in concrete, empirical scholarship tracing the evolution (or involution) of real clusters with their real cluster industrial dynamics, remain to be performed.

Clusters and entrepreneurial dynamics

Recent work on cluster dynamics has sought to bring out the complex inter-connections between the working of cluster dynamics and their impact on the rate of formation of new firms, and on the subsequent growth of firms, i.e. on the link between clusters and entrepreneurial dynamics. Intuitively, one suspects that there is such a link, and an important one—but demonstrating it has proven to be extremely difficult. The traditional work on the growth of firms has tended to be framed by the 'stylized fact' of Gibrat's Law (1931) under which it is claimed that the size of a firm and its growth rate are independent. Much effort has been devoted to trying to 'prove' or 'disprove' this law, particularly in the field of smaller enterprises where growth rates are critical to survival.[73] Garnsey, Stam and Heffernan (2006) review the evidence relating to a Penrosean, cumulative and process approach to understanding firm growth, and insist (in my view correctly) on systemic feedback processes as being central. But the analysis remains tied to the level of the firm itself—and yet it is clear as soon as one takes a cluster perspective that firm growth and

application such as Gersick (1991), Ring and Van de Ven (1994) and, most recently, Antonelli.

[72] Much work in evolutionary economic geography is now devoted to explicating the sources of path dependence (and possibilities for breaking free of it); for a recent critical review, see Martin and Sunley (2006).

[73] Much of this work has been reported and debated in the journals *Small Business Economics* and *Industry and Innovation*; for a recent reviews, see Stam (2010) and Garnsey, Stam and Heffernan (2006).

survival depend as much on the cluster and the links between firms as on the firm's own growth strategies. From the point of view of the cluster, new firm growth might be accommodated within existing firms, but it is more likely to be found in new firms being formed and in existing firms creating new branches—so that the growth is a cluster-level phenomenon and the its evolutionary dynamics should be a primary concern of economic geographers as much as scholars of entrepreneurship (Frenken and Boschma 2007).

The very recent work by the Porter Cluster Mapping project (Delgado, Porter and Stern 2010) makes an important distinction between the cluster effect of suppressing entrepreneurial activity, through raised levels of competition for resources (which they term convergence) and the cluster effect of promoting entrepreneurial activity, through widely recognized economies of agglomeration and emulation effects. It complements recent important work that identifies industrial clusters in a dynamic, longitudinal setting where the effect of the cluster on the survival and performance of new firms is central.[74] These studies are a pointer to what may be accomplished in this relatively youthful scholarly field. Studies designed to replicate the findings in India and China, and

[74]See important studies on this theme by Wennberg and Lindqvist (2010) on clusters of Swedish firms and their impact on firm growth over the period 1993 to 2002; and the earlier study by Braunerhjelm and Carlsson (1999) which compares industrial clusters in Ohio and Sweden over the two decades 1975 to 1995, where they establish a methodology for identifying clusters that is grounded explicitly in 'cumulative causation' reasoning, and is of more general applicability. The key concepts introduced by B&C for cluster measurement and identification are 'location quotient' and input-output interconnections captured as 'contacts'. Porter (2003) provides a review of some longitudinal descriptive work on US clusters, while Glaeser, Kerr and Ponzetto (2010) provide econometric evidence seeking to lay bare the respective influences of entrepreneurship and cluster dynamics on firm growth, building on earlier work by Ellison, Glaeser and Kerr (2007). Rosenthal and Strange (2004) provide a comprehensive review of the work in this area accomplished up until the end of the 20th century.

indeed deepen the findings based on Chinese and Indian industrial cluster dynamics, would be welcome.[75]

How then do clusters work?

Theses as to successful development of clusters

Given these considerations, what then can we say about how successful industrial clusters are started, and how they work? Drawing on the insights discussed, I wish to frame a set of ten theses which will both encapsulate the lessons from existing industrial clusters (both successful and unsuccessful cases, or rather the evolutionary process through which clusters emerge and then devolve) but will also lay down a set of guidelines according to which new industrial clusters might be expected to be formed and flourish, through targeted interventions. By the very nature of the subject, such an account would have to call on economic as well as strategic reasoning, combined with organizational and entrepreneurial insights.

Firstly, and most fundamentally, what is a cluster? Clusters are above all a concentration of economic activity, where all the processes visible in the economy at large are focused, concentrated—and indeed clustered. There are three aspects to this process of industrial concentration or clustering: a) the firms need to be specialized and co-specialized in some particular product or group of products calling for commonalities in activity chains; b) the firms need to be inter-linked or inter-related in some way to generate something

[75]The Delgado, Porter and Stern (2010) study builds on recent empirical investigations of links between entrepreneurship and clustering, including Glaeser et al (2010), Feldman et al (20005), Acs et al (2009) and Wennberg and Lindqvist (2010). This is clearly an important area of scholarship that awaits expanded engagement with the cluster phenomenon in China, India and elsewhere.

beyond mere agglomeration economies; and c) the firms need to have some geographic concentration (even allowing for the important role played by flagship firms from global production networks).[76] Specialization and co-specialization has always been seen as fundamental to cluster identity; it was there as one of the features of Marshall's original description of 19th century industrial districts, and is now the key to the identification of 'specialized towns' in southern China as recipients of provincial government assistance in creating common R&D platforms. The firms that make up a cluster have to be inter-related and inter-linked; if not, they capture no more than agglomeration economies, available to atomistic firms merely through co-location (such as shared pools for labour supply, common services, utilities and such). These can be of considerable advantage—but to be called a cluster, an industrial complex (Gordon and McCann 2000) needs to have the 'extra' provided by systemic interactions and inter-dependencies. The inter-linkages between firms need to result in repeated interactions, which build effective inter-firm routines and the dynamic capabilities embodied within them, as well as intangibles such as trust. These interconnections can be characterized in different ways, such as by calling them 'asset mass interconnectedness' but they always get at the same point, which is that a group of interacting entities can, through their interconnections, create 'systemic' gains which are not available to any member on its own. Call them 'externalities' or 'external returns' or simply 'increasing returns'—but in their fundamentals they are systemic gains attributable to the systemic properties of the cluster. These emerge either spontaneously, through successive co-location decisions taken by firms leading to interdependencies, or in a planned fashion, as in Chinese and

[76] Martin and Sunley (2003) in their comprehensive critique of Porter's notion of cluster make the point that Porter refers to geographic co-location and inter-connections as important features, but seems to leave the specialization in certain activities as an implied defining feature. But closer attention to his Cluster Mapping project reveals that measures of specialization figure strongly in Porter's empirical work on clusters

India SEZs, as part of a purposeful catch-up strategy. And of course firms in clusters need to have some geographic co-location, as emphasized in the economic geography literature. When the role of global production networks is brought into the picture (e.g. Yeung et al 2006; Yeung 2009), it is through the intervention of a regional representative of the flagship firm seeking to develop a clustered supply chain around its operations in some given locality. So it is a concentration of economic activities (in these three senses) that must be taken as primary in determining what is a cluster, both in terms of identifying empirical manifestations of cluster activity and in terms of promoting clustering as an industrial goal.[77]

Secondly, the cluster expands the market available to its individual member firms; this too is part of its fundamental rationale. The cluster acts like a pump, in that it pulls in revenues from the surrounding economy to the firms located within the cluster. Consider the case of an IKEA, a firm that starts as a retail outlet for furniture and recruits furniture producers to act as its specialized suppliers; as it grows, it offers such suppliers access to a far larger market than they could hope to achieve themselves, or through generalized distributors. In this case, IKEA acts as the instigator, or as prime mover (anchor firm) of the cluster, which becomes a global value chain. In other cases, such as the Italian industrial districts like Prato in textiles, the conjunction of firms in one region is driven by their providing specialized intermediate services in a chain of production that is disintegrated, and by doing so, they create the conditions for an expanded market for their joint output, e.g. in opening up export markets that would be beyond the

[77]This emphasis on concentration of economic activities is designed to align with the literature on networks following power density laws, as elaborated by Barabasi and others in the natural sciences literature. Despite the difficulties encountered in verifying the reality of clusters through statistical investigations or verifying their positive impact on innovation (e.g., Harrison et al (1996) on US metal fabrication clusters) it is *clusters as concentrations of economic activity* that must remain primary.

capacities of any firm on its own. The expanded market is ultimately the source of increasing returns—whether counted as internal or external.

Third, the firms that come together to form a cluster need to do more than collect external returns from each other (and from outside the cluster); what they need to do is to establish an identity, as a self-identified cluster, in some form of joint action. This could be a process through which an export market is created, via the cluster firms combining their efforts and capital to create an export consortium, and/or establish trade fairs both within the cluster (to bring customers to the cluster) and in key export destinations (to reach customers otherwise unattainable).[78] It could be a process through which the cluster firms create a joint services organization, to provide training for recruited labour, as well as marketing intelligence, and promotional activities. It could be joint action to set up and operate an R&D institute, to solve technical problems and pass the solutions to all the members of the cluster, thereby enhancing their joint collective advantage. Schmitz (1999) introduced the idea of collective efficiency as accruing to firms that are able to mount joint action (an active concept) with the collection of external economies (a passive concept). The idea is that clusters, to be successful, need to fashion a form of joint action that directly involves the member firms, and helps them give the cluster an identity. This is indeed a fundamental observation, amply validated in the clusters that Schmitz and colleagues have looked at, and in others.[79] The most recent work on southern China clusters, in towns throughout the

[78]Marshall himself was at pains to point to this feature of the British and German industrial districts, where he noted the significance of industry and trade associations in giving the district an action-orientation and, thereby, an identity. On this, see Belussi and Caldari (2009).

[79]See for example the accounts of the shoe clusters in Brazil (Schmitz 1995), in Mexico (Rabellotti 1995) and the surgical instruments cluster in Siot, Pakistan (Nadvi 1999). For a summary statement of the 'collective efficiency' perspective, see Schmitz and Nadvi (1999).

province of Guangdong, likewise makes the point that the identification of 'specialized towns' is done for the purpose of providing such designated towns with financial assistance in forming and operating collective service centres (e.g. for R&D, for collecting market intelligence, and even for mounting joint efforts to attract buyers or mount export operations.[80]

A fourth condition for success, and one that is frequently observed, is that the cluster needs to be open to the wider economy, nationally and globally. This is obvious in terms of trade (where exports are the lifeblood of the cluster).[81] But it is

[80] Arvanitis and Jastrabsky (2006) provide a description of how this works in practice in China. 'Xiqiao and its cotton textile industry is the perfect example of the success of this policy [of identifying Specialized towns]. The locality had 1,670 textile enterprises for the printing and spinning of all kinds of fabrics, for both furniture and clothing. The annual sales of this locality amounted to 13 billion yuan. The sizes of the factories were so small and varied, and the technical level so low, that the enterprises could see no point in initiating R&D activities. In May 1999 the [provincial] government set up an innovation centre. Since then the centre has created over 8,000 products (computer assisted textile designs). Every day the centre's personnel visit the enterprises. This is how Xiqiao is moving from imitation to innovation…. The initial investment was 7 million yuan, and the centre quickly became self-sufficient by the sale of its services.' (2006: paragraph 37). The parallels with efforts to upgrade technical capabilities in European industrial districts like Prato, through similar common service platforms, are clear. Moreover Arvanitis and Jastrabsky drive home the point that there is a cumulative process at work here, with one collective asset creating the platform for further cluster asset creation: 'Moreover, the [Xiqiao centre] participated in a major effort to computerise the enterprises, ensuring the development and maintenance of the local computer network. More recently, in 2004, the government of the province decided to set up a technical university specialising in textiles and to ensure that the locality of Xiqiao became a centre [growth pole] for technology development at a national level' (2006: par 37, p. 14). This process, so clearly characterized here, can easily be translated into the language of (collective) asset mass efficiencies as utilized above.

[81] The recent study of clusters and entrepreneurship by Delgado, Porter and Stern (2010) finds that the positive effects of clusters on entrepreneurial dynamics are confined to what they describe as 'traded clusters', i.e. clusters

no less important in terms of openness to capital flows—i.e. Foreign Direct Investment (FDI) facilitation—and to flows of labour in the form of immigration. Openness to trade means concentrating efforts on servicing export markets, and in building infrastructure to handle exports of finished goods and imports of intermediates—as in the earlier years of Export Processing Zones and Free Trade Zones that preceded today's industrial clusters. Openness to FDI means having the institutional infrastructure to enable multinationals to directly invest in clusters (like Nokia in the Xingwang industrial park) and to capture the knowledge spillovers generated. And openness to skilled migration means again having the physical infrastructure (such as housing and transport) and services infrastructure (health, education, utilities) as well as the institutional infrastructure to allow for flows of migration without damaging local culture—as China seems to have managed within the setting of its SEZs. In the case of Silicon Valley, Saxenian (2002) has made a strong case that its continuing success is due in no small measure to this openness to flows of knowledge, capital and above all people—particularly Chinese and Indian entrepreneurs. The hundreds of clusters being formed in China and India are all a product of the openness associated with globalization, so that the local cluster interacts directly with a global value chain—bringing the local and the global into alignment.[82] This

doing business with the outside world. Other more inward-looking clusters do not generate such positive effects.

[82] The literature on clusters and economic geography sometimes seems to pose the interaction between local clusters and global value chains as problematic, as if the seeding of a local cluster by a flagship firm is at odds with the geographic co-location focus of cluster scholarship. Clearly clusters need to be started by some triggering event, and the recent scholarship on Chinese clusters reveals that this triggering event can be a top-down driven initiative by a flagship firm (such as Nokia initiating the Xingwang industrial cluster in Beijing) or a bottom-up driven process such as the clustering of third- and fourth-tier suppliers to electronics and IR value chains in Guangdong (Chen 2007; Yang 2009). In my view, the way to view the cluster is to see it as the product of both top-down and bottom-up

openness to the outside world, particularly to the influence of global firms in Chinese and Indian clusters, means that as much attention needs to be paid to external links as to the internal links within the cluster.[83]

A fifth factor for success concerns the capacity of the industrial cluster to reach out to link with other clusters so that they eventually form a highly-connected network of firms and transvections encompassing several 'clusters'—at a higher level of recursion. The same point can be made in terms of an existing cluster's capacity to seed future growth paths along related but different lines—so as to avoid being locked-in to a single pathway which will inevitably turn from evolution, growth and expansion to involution and decline. We might characterize this process as one where clusters are seeking to connect with wider and wider pools of entrepreneurial capabilities. Some commentators point to the multi-level features of clustering as a deficiency in definition and leading to confusion—yet the reality is that such recursion at multiple levels, as more and more clusters are encapsulated within a single town or city, is what gives the cluster its systemic strength and drives its development. That this makes for empirical difficulties of identification and measurement should be seen by scholars as a challenge, not a weakness.

These are the five prime conditions for firms operating together in ways that can be described as cluster-like, and they generate entrepreneurial and evolutionary dynamics that lead to

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initiatives, with the former emphasizing strategic intervention and the latter spontaneous clustering following economic imperatives.

[83] As Humphrey and Schmitz (2002) put it: The recognition of the importance of clustering has put economic geography back at the centre of the economic development debate … However, the preoccupation with the quality of local linkages has led to a neglect of the global linkages'. Humphrey and Schmitz suggest that this question of external linkages and their governance should be at the centre of Global Value Chain (GVC) concerns; they suggest indeed that local upgrading opportunities vary with the way chains are governed.

successful outcomes (and can proceed to degeneration as well). A sixth thesis concerns the evolutionary dynamics that are generated within such a duly formed cluster. As the market expands, so the possibilities for specialization by firms as suppliers of intermediate inputs grow, in the process of intermediation described above. It was the American scholar at the LSE, Allyn Young, who best captured this process in his paper to the Economic Society (Young 1928), as one where expansion of the market breeds further specialization, and further specialization in turn grows the market. The enhanced market power of the cluster creates the conditions for parallel development of multiple value chains, with the firms in one chain cross-connecting with the firms in other chains as suppliers and customers. In the context of developing economies, Rosenstein-Rodan memorably characterized this simultaneous expansion across multiple activities as the 'Big Push', meaning that investments across a range of activities could together, jointly, generate returns unavailable to each investment project on its own. Rosenstein-Rodan and his popularizer, Ragnar Nurkse, characterized this as a process of 'balanced growth' (meaning that the demand generated by multiple outputs could balance supply), while Hirschman insisted that the process involving multiple forward and backward linkages (interfirm connections) would result in 'unbalanced growth'—in the sense that it would proceed in a disequilibrium manner generating increasing returns. Effectively the two schools were talking about the same process, called by the great developmental theorist Myrdal one of 'circular and cumulative causation' and applied to both regional clusters and whole economies by the anti-orthodox British economist Nicholas Kaldor. Kaldor was the author of the felicitous way of characterizing this process as a 'chain reaction'—in the sense that each round of transactions, or each iteration, leads to new possibilities for subsequent iterations, each one generating superior returns. All of this lies behind the current discussions of cluster dynamics and the 'new economic geography'. The point is that clusters generate a process of development that is: a) accelerated; b) circular, in that one gain

feeds off another; c) cumulative in its effects; d) path-dependent; and e) capable of generating systemic gains that are traditionally known as 'increasing returns'. This is the powerful combination that makes industrial clusters such desirable organizational entities, and the source of such wealth where they have developed spontaneously (as in Europe) and the object of so much policy attention elsewhere such as in China and India and in East Asia and Latin America.

An essential precondition for such clusters with their desirable industrial dynamics to form is that the legal and institutional setting for the cluster be favourable. The example *par excellence* in this regard is of course Silicon Valley, with its overlapping clusters that started in ICs and IT and now encompasses clean tech, renewable energies, biotech, and many other kinds of clusters together with their highly specialized services. But not everyone can hope to emulate the success of Silicon Valley—in spite of numerous attempts.[84] China has gone some way to creating a favourable institutional environment for clusters in its Special Economic Zones, which are now spreading rapidly through the inland areas away from the coastal cities, and now in India as well. These SEZs have proved to be adept at trying out new ways of promoting local industrial development, leading to such outstanding successes as Shenzhen in China and Sriperambudur in India.

The theses outlined here call for validation not only through real-world cluster experience, in China and elsewhere, but also in computer-based simulation on realistic models of cluster formation and dynamics. This is where agent-based computational economics (ACE) makes its entry, and where

[84]The historian Margaret O'Mara documented the rise of Silicon Valley (2004) paying close attention to the gradual and systemic build-up of elements, noting in her latest contribution (O'Mara 2010) that Silicon Valley imitations cannot be created overnight. A similar point was couched in strategic terms above in characterizing the 'causal ambiguity' inherent in an industrial cluster.

there has been some (slow) progress recorded to date.[85] For example, Zhang (2003) was able to build a Nelson-Winter style evolutionary model with explicitly defined landscape where clusters were formed spontaneously through concentrated entrepreneurship. This series of simulations also demonstrated properties of first-mover advantages and path dependence, as well as clustering of innovations. But the crucial feature, of the evolutionary dynamics of the clusters towards stable activity-configurations, was not attempted, nor was there any semblance of 'circular and cumulative causation' dynamics. To capture such features in agent-based models remains a challenge for the field.

Three strategic perspectives on clusters

A cluster that has grown in this way can be considered strategically from three perspectives—those of its a) cluster resources that underpin the cluster's activities, b) the activities that are interconnected to create the cluster, and c) the routines that link these resources with firms' activities.

Resources: The cluster resources form a 'bundle' (as in the Penrosian account of the firm-level resource perspective) that enables firms to specialize their resources (such as production technologies), exchange and recombine their resources, in a process that may best be characterized as an ongoing process of resource reshuffling. A direct analog is the genetic reshuffling that drives biological evolution. In the case of biological evolution, reshuffling of genetic endowments across thousands and millions of generations produces huge variety that is tested in its outward manifestation in terms of protein synthesis and other activities of the cell and organism (i.e. in terms of phenotype). This generation of variety and its testing over multiple generations leads to far 'fitter' organisms in terms of

[85] See Fioretti (2006) for a review of recent studies using agent-based models of industrial clusters and districts.

their adaptation to a particular environment than any process of 'rational design' might hope to accomplish.[86] Likewise in the case of the industrial cluster, the reshuffling of resources across multiple firms and their value chains leads to an 'experimental' (or non-predictable) outcome that can be expected to be superior in terms of its 'collective efficiency' than any prior specified resource allocation by a single large firm.[87] The driver behind this anticipated superiority of the cluster over the single firm lies in its resource variety (or heterogeneity) which in turn drives capacity for adaptation.[88] What is the strategic goal that

[86] In the setting of the development of strains of yeast that can be used for production of ethanol from fermentation of lignocellulose (e.g. whole sugar cane plants), Attfield and Bell (2006) describe a technological breakthrough where they use accelerated Darwinian evolution to produce such a strain, and compare this with the two decades and more of frustrated efforts to produce such a strain through genetic modification (splicing a genetic sequence from one microorganism that can ferment the relevant sugars into the yeast genome). The development of such natural yeast strains via accelerated directed evolution, or what has been called 'population genetics' approach as opposed to genetic modification (termed 'rational design') is a major technological breakthrough. It has direct implications for our discussion of the 'breeding' of novel resource combinations in industrial clusters, as opposed to the rational design of resource configurations in a single integrated firm.

[87] In her interesting study of the Uppsala biomedical cluster, originally focused on the firm Pharmacia, Waluszewski (2004) insists on the reshuffling of resources as lying behind the cluster's dynamism, where she uses the phrases 'combinatory resources' and 'resource switchboard' to emphasis this turnover of resources between firms and the university. Waluszewski emphasizes that the roots of success of this cluster lie in seven decades of resource recombinations—just as Sturgeon (2000) argues that the recent successes of Silicon Valley are grounded in many decades of resource recombination and concentration in electronics and telecommunications.

[88] In the setting of biological evolution, the founders of punctuated equilibrium theory, Gould and Eldredge (1977) state: 'Population geneticists recognized … that a primary datum of their profession would be a measure of the amount of genetic variability in natural populations' (1977: 116). After an enormous amount of argument, the consensus emerged that variation in natural populations is copious. The equivalent statement for cluster evolutionary theory would concern the degree of resource variety (or heterogeneity) within the cluster and, through interacting clusters, within the

drives the reshuffling of resources? It is the pursuit of complementarities, or synergies, or what Richardson (1972) in his pathbreaking study called 'close complementarities' between firms that gave industry a structure or an 'organization' that went beyond either markets or hierarchies. There is no counterpart to this notion of dynamic complementarities as a strategic goal in neoclassical equilibrium theory.

Activities: The advantage for a firm to be a member of such a cluster is that its activities can be connected to those of other firms, thus 'closing' a series of such connections that culminate in a product or joint products (this is what Alderson memorably called transvections, which are totalities within the totality of the cluster). What Marshall noticed more than anyone else up to his time was that firms within such a 'transvection' benefit not just from the organizational improvements that they could muster for themselves (their internal economies), but also from the improvements generated by each and every firm in the entire transvection, or what Marshall termed external economies. This clearly goes a long way to explaining cluster benefits—but as Schmitz (1999) insists, there must be the further element of joint action between the firms involved (such as in adapting their production equipment to the specific needs of their customer or supplier firms) to capture what Schmitz calls 'collective efficiency'.

The emphasis in the evolution of the configuration and reconfiguration of firms' activities must lie on the patterns thus executed, rather than on the nature of the activities themselves—another case of the whole being more than the sum of the parts. It is the linkages between the firms, and the evolutionary process through which the cluster arrives at a particular configuration of linkages, that is of prime interest. We might pose a dynamic counterpart to the static notion of

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economy as a whole. One could make the argument for capitalism that it generates far more resource heterogeneity (variety) within clusters of firms—and hence their adaptability—than any other system.

pareto efficiency, whereby we define a new linkage between two firms as being evolutionary pareto efficient if it improves the profitability of at least one of the firms in the cluster, without making anyone else worse off. We can then envisage an evolutionary process that proceeds through the creation (and dismantling) of interfirm linkages, each such configuration defining a maximal output (or measure of performance) for the cluster as a whole, until the point is reached where no further pareto efficient shifts are feasible. The cluster would then have reached an evolutionary stable state (ESS)—depending on the technology employed and the mix of inputs available.

This then may be posed as a challenge for the field—namely the challenge of proving theorems for the cluster industrial dynamics which would be the (genuine) dynamic counterpart to the theorems proving allocative efficiency of a competitive equilibrium in neoclassical economics. Noone knows whether the competitive equilibrium of which so much fuss is made actually exists, or could ever exist—despite our knowing that it is pareto efficient etc. But let there be no doubt about the reality of an evolutionary stable state reached through a process of shuffling interfirm linkages in a cluster until a state is reached where no further shifts are possible in a dynamic sense of pareto efficiency. The ESS is real—as witnessed by the millions of such ESSs found within the biological world, where the ESS represents a stable ecological setting, given a set of species and their resources.

Hao Tan and I have used this idea in the context of eco-industrial initiatives, where firms are making connections with each other in order to reduce wastes and enhance recycling. One firm's waste becomes another firm's input—and such linkages can be pursued by firms, making their own profit calculations, in a given set of pricing parameters, until no further opportunities are available. This is what we called an evolutionary stable state that is eco-efficient in a pareto sense—where no firm can make itself better off without making some other firm worse off. The ideal type of this kind of

evolutionary stable state is what the Chinese call a Circular Economy (or the Japanese a Sound Material-Cycle economy, and the Germans Minimization and recovery recycling economy) (Mathews and Tan 2010). It represents a radical departure from the standard linear 'resources in' at one end and 'wastes out' at the other, without regard to the connections between the 'resources' and the 'wastes' in the services provided by nature herself. It is surely relevant to note that the places where such recycling ideas are most advanced in China is in the industrial clusters, and particularly in the SEZs like Shenzhen that 'cluster' a group of clusters.

So we can now give some content to the notion of a strategic goal for the shuffling and reshuffling of activities across various transvections within a given cluster, in that the firms making up the cluster are consciously seeking to expand the market for their joint output, given their existing level of inputs. Expanded output for given input is known as increasing returns, and now through the medium of the 'new growth theory' and the 'new economic geography' the idea of increasing returns is coming back into mainstream economics, whereas it was banished by the spurious focus on the conditions governing attainment of a fictional perfectly competitive equilibrium.[89] But as I have emphasized many times before, strategizing does not have to be constrained by such artificial and other-worldly economic theorizing. Firms can frame their strategies in terms of linking

[89]On the new economic growth theory and its reliance on increasing returns, see Romer (1986; 1987) and for the new economic geography, see Krugman (1991). Despite their use of increasing returns, both frameworks continue to rely on equilibrium-based reasoning, and therefore do not get to grips with the real 'circular and cumulative causation' evident in cluster industrial dynamics. Bhattacharjea (2009) provides an interesting link between the new economic geography and Kaldor with his C&CC reasoning. On the manner in which the assumption of constant or diminishing returns was introduced into economic analysis more or less as an afterthought, as an assumption with zero supporting empirical evidence, simply to make the factor contributions 'add up' at equilibrium, see Buchanan and Yoon (1994; 1999).

their activities in pursuit of increasing returns—which is what firms do in practice, in reality, whether economists have been prepared to recognize the fact or not. The huge productivity gains associated with the clustering of firms in manufacturing industrial districts are testament to the power of increasing returns.

Routines: What links activities with resources is the set of routines that operate between the firms in the cluster. The routines link the productive assets (resources) with the productive activities, and as they are repeated and refined, so they generate dynamic capabilities. The cluster routines may be characterized as simple rules governing interfirm behaviour, such as firms within the cluster extending work to each other on a cost-plus basis, without seeking to profit from such shared activities. Such a rule would ensure that the profits accruing to the cluster as a whole come solely from customers external to the cluster, and not from one firm within the cluster exploiting another. Such a rule becomes embedded in the cluster through repeated application, as different firms receive external orders and share the proceeds with specialized members of the cluster. More complex rules might apply to the ways in which firms work together on joint R&D projects, developing some new product or service in prototype form which they can share before adding their own distinctive adaptations to it—and improving the process as it is repeated sequentially—as in the case of Taiwan's R&D consortia. These embedded rules become the intellectual property or stock of the cluster as a whole, and may be described as the cluster's higher-order capabilities.

Firms within a cluster can strategize around routines in such a way that they strive for these cluster-level capabilities, to capture the benefits they provide (such as cognitive coordination and the trust that it generates). Again, it needs hardly to be pointed out that such learning effects, at either firm-level or at population-level, have no counterpart in the world of neoclassical equilibrium economics; they belong to a

realm of strategizing that I have argued should view its goals as *sui generis* and not subordinate to some purported over-arching economic rationality. Moreover they call for determined empirical studies to unearth them, and bring such largely tacit routines into the light of day.

The 'highest-order' industrial capability that a country can strive for in enhancing its national competitive advantage, is the development of routines for the successful seeding and nurturing of new clusters. This is what I was getting at in my notion of 'economic learning' as being the counterpart for national and regional levels as 'organizational learning' at the level of the firm.[90] It is clear that in the sense I am using the term, some countries and some industries 'learn' economically better than others. The more that clusters succeed, the more they create conditions favourable for further clusters to be formed, creating a feedback loop between entrepreneurial and cluster dynamics that may be viewed as a powerful engine of wealth generation. The successful cases point to instances where the institutional framework of the economy has been built to anticipate and facilitate the kind of accelerated transfer and uptake of knowledge (in the form of routines) that Baumol (2002) argues is the greatest contribution of the free-market economy and the fundamental reason for its success.

Let me now summarize the ten theses outlined above, as governing the success of industrial clusters established to date, and likely to provide effective guidelines for creating new successful clusters in the future.[91]

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[90] In Mathews (2002) I outlined this notion of a 'national system of economic learning' with its emphasis on repeated creation of new industries by competitive catch-up or fast followership—as opposed to the notion of 'national system of innovation' with its connotations of R&D-led innovation being necessary for economic success. The successful cases of catch-up in East Asia demonstrate clearly that imitation comes first, and then the innovation.

[91] Harrison White (2001) in his account of the emergence of US industrial

1) *The cluster concentrates economic activity*

   The defining feature of a cluster is its concentration of economic activities, through the creation of multiple interfirm linkages. Clusters exist as structures within the overall economy, or industrial market system; in that sense they function as 'suprafirm structures' whose rules of operation have little to do with conventional equilibrium-based economics.

2) *The cluster expands the market*

   The most important 'output' of a cluster is its expansion of the market for the goods or services of the firms making up the cluster. This is the source of the increasing returns that are widely observed to be generated within clusters. This market expansion is the single most important economic indicator for the member firms within the cluster.

3) *Collective efficiency: the cluster defines itself through joint action*

   Simple agglomeration economies are available to firms attributable to co-location, and Marshall's external economies likewise flow to firms through interlinkage. But to really generate cluster dynamics the firms need to launch joint actions of various kinds (e.g. export consortia). The combination of joint activity with external economies generates collective efficiency.

4) *The cluster is open to flows of goods (trade), capital (FDI) and labour*

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markets from networks, likewise summarizes his findings as a nine-point 'model' as follows: 1. The firms involved are small in number; 2. The emergent market has an identity; 3. There is inequality between firms in the market; 4. Businesses are profit-oriented; 5. Production markets generate increasing returns; 6. Higher quality can accompany lower costs ('perverse returns'); 7. Monopoly is rare; 8. Products and industries move through life cycles; and 9. Decoupling: Local variabilities and path determine market aggregates, which are historical, not accounting outcomes. White's nine elements, and the ten theses offered here, clearly overlap in some respects, but are focused on different processes.

Clusters are self-contained islands of concentrated activity within a wider economy (to paraphrase Richardson (1972), but they are islands that are open to fundamental economic flows—flows of goods and services (trade), of capital (FDI) and of labour. These provide the 'nutrients' needed by the cluster, and call for careful construction of physical and institutional infrastructure.

5) *The cluster strives to link with other clusters at a higher level of recursion*

   Clusters that remain specialized in a particular set of activities without linking up with related transvections that create wider and wider areas of cross-linkage and interdependencies, risk moving from an evolutionary pattern of growth and expansion to an involutionary pathway of lock-in and decline.

6) *The successful cluster exists in an institutional environment where the evolutionary dynamics of 'circular and cumulative causation' can work their magic*

   A cluster founded according to these five theses can still fail, if its operating environment is unfavourable. Countries and regions only secure the full benefits from clusters when they create a favourable business, legal, tax and entrepreneurial environment within which circular and cumulative causation processes can work their magic.

7) *From a resource perspective, the cluster's evolutionary strength lies in the shuffling and reshuffling of its collective resources*

   Clusters are rich in resources, and it is the constant shuffling and reshuffling of these resource bundles—creating the cluster-level analog of the genome of a species—that drives their evolutionary dynamics, and generates outcomes that are likely to be superior to the 'rational design' engaged in by single, integrated firms. Firms strategize around this resource

reshuffling with a view to capturing complementarities and the gains they generate.

8) *From an activities perspective, the cluster's strength lies in the configuration and reconfiguration of activity chains (transvections)*

   Clusters are basically collections of revenue-generating activity chains, or transvections, which like their underpinning resources are shuffled and reshuffled by the firms that operate these transvections. This is done in the pursuit of increasing returns (or at the firm level, productivity improvements) which experience indicates are abundantly available in cluster settings. These activity patterns and the increasing returns they generate are the cluster-level analog of the phenotypical expression of genotypes.

9) *From a routines perspective, the successful cluster builds interfirm routines and then endlessly improves and upgrades them, to capture cluster-level learning or 'higher-order capabilities'*

   Clusters are also rich concentrations of interfirm routines, which ensure that the cluster as a whole earns its revenues from drawing in customers from outside, rather than from exploiting each other within the cluster. The improvement and upgrading of these routines results in the generation of cluster-level competences and higher-order capabilities, which account for the 'causal ambiguity' of successful clusters.

10) *The process of cluster creation and nurturing needs to be repeated over and over, as the central component of national and regional competitive advantage*

    Clusters are long-term creations (some lasting for hundreds of years) but they eventually wither and die. The ultimate 'higher-order capability' for a nation or region lies in its capacity to seed and nurture new clusters, as industrial evolution throws up new opportunities and entrepreneurial firms look to take advantage of them. There is no end to the process of

cluster creation—and the process of cluster formation can be expedited in each iteration by the learning embodied in the previous experiences.

Clusters: industrialization; urbanization; globalization

Finally, let us step back and review the dominant trends of our time, trends that are shaping our industrial civilization—globalization, industrialization and urbanization— and how industrial clusters stand at the intersection of all three, contributing to them and clearly expressing their influence. ***Globalization*** may be understood as the dismantling of barriers that have traditionally kept countries and regions locked away from each other, and in the process expanded markets and made new forms of specialization and outsourcing feasible—such as the strong trend towards outsourcing of steps in the manufacturing value chain, and steps in business processes (business process outsourcing or BPO) creating the new phenomena of global value chains. ***Industrialization*** may be understood as the shift from traditional economic activities such as subsistence farming towards higher productivity activities such as manufacturing—a shift that entails structural transformation and new growth paths. The industrial revolution in Britain, then in Europe and the US, then spreading to Japan and then to other east Asian countries, and now in the 21st century encompassing the huge countries of China, India and Brazil, is best viewed as a 200-year global socioeconomic and industrial process that drives through traditional obstacles and promises new levels of wealth generation wherever it is allowed to work its magic. ***Urbanization*** is the third of these modern apocalyptic forces, driving humans to become city-based dwellers for the first time in our 50,000-year history as a modern species. In a series of articles based on his dramatic forthcoming book, Saunders (2010) argues that between now and 2050, the world's cities will absorb an additional 3.1 billion people. By the end of 2025, 60% of the world will live in cities, up from around 50% now; by 2050 the figure will likely be

more than 70%; and by the end of the century, the entire world will be as urban as the west is today. Saunders argues that this will represent an end-point, from which there can be no turning back. Furthermore, he argues that this will be a profoundly progressive shift, as urban life encourages the shift in behaviour and values that will be critical to the planet's survival (as opposed to the popular stereotype of people moving from the countryside to cities to live in shanty towns).[92]

Now industrial clusters are central to these three profound trends that are shaping our industrial civilization. As seen in the rise of SEZs in India and China, industrial clusters represent the kernel of a new, progressive, outward-oriented and innovative kind of economy that can generate high levels of wealth (investment, employment, output) and which will eventually transform the entire economies of China and India and then will doubtless be emulated throughout the remaining parts of the developing world. Industrial clusters represent a new kind of intersection between the local and the global, as seen in the influence of global value chains in the creation and growth of SEZs in India and China. Clusters encapsulate the processes of industrialization, driving it forward in the circular and cumulative causation processes first described by the Swedish economist Gunnar Myrdal and taken over as central to his dynamic, non-equilibrium economic analysis by Kaldor. And clusters are central to cities, while cities are basically expressions of clusters—as the new literature on cities as creative fields, innovation and entrepreneurship makes

[92] Saunders (2010) stands comparison with the earlier studies of cities by Jacobs (1961; 1969) and of comparisons between New York and Pittsburgh (Chinitz 1961). The comparable studies today would be those examining differences between, say, Shanghai and Guangzhou, or more specifically between Suzhou in the Yangtze River Delta and Dongguan in the Pearl River Delta.

abundantly clear.[93] Industrial clusters are thus central to the further evolution of our industrial civilization.

Concluding comments

Once we shift the focus away from firms as such, to the interactions between them, and to the structures they create through this mutual interaction, we open up so many new insights where strategizing intersects with traditional (but non-mainstream) economic concerns such as cluster and network dynamics. The focus thus shifts to investigate the "worlds that firms mutually create"—to adapt a striking phrase of Kauffman (1996). At the level of the economy as a whole, the patterns that result from these interactions are emergent; they are beyond the control of any individual firm, or even of any group of firms. They provide the context within which strategizing must necessarily proceed. It leads to behavior that builds networks, alliances, platforms, clusters and other supra-firm structures. These processes are the engines of dynamic economic response to changing conditions far from equilibrium. They are suppressed in conventional microeconomic analysis that is focused almost exclusively on the atomistic firm and on the comparative statics of what goes on at equilibrium.

The key organizational insight arising from such considerations is that economic performance is not optimized by simply seeking to optimize the performance of each individual productive resource, on its own. Nor is economic competitiveness likely to be enhanced simply by looking at firms on their own, but in relation to networks—frequently spanning several countries. Thus a viable and plausible national

[93] The British geographer working in the US, Allen Scott, has contributed to this line of thinking over many years, from his early essays (Scott 1986) to his recent (Scott 2000; 2006). In this work, the city and the cluster are the two points of reference, both feeding into each other and each being influenced by the other.

economic learning strategy can be couched in terms of promoting linkages between domestic and foreign firms, rather than in terms of the more traditional approach of promoting domestic value chain formation. The organizational dimension is essential in order to deal with the issue of coordination. The organizational dimension operates at several different levels—bundling resources in firms to capture synergies, and then connecting firms with each other to capture further synergies, and then connecting groups of firms with other groups of firms to capture further synergies again.

These are the features that are brought out in a strategizing account of the emergence of networks, clusters and other suprafirm structures. I wish to emphasize that these are not the product of 'economic laws' and deterministic processes, but the outcome of mutually conditioned entrepreneurial initiatives on the part of groups of firms seeking mutual advantage.

Thus the study of industrial clusters promises not just a lively debate informed by new empirical work, particularly on clusters emerging in China, India and elsewhere, but an engagement with the very foundations of economic reasoning. When dealing with clusters, the standard comparative static tool kit developed by economics, and carried over into strategic analysis, just does not generate the insights needed for serious investments of time and money in new cluster developments. An evolutionary perspective is, in the case of clusters, a necessity rather than a luxury. An approach that links the micro to the macro through agent-based simulation is a necessity in understanding the complex ways in which path dependence may be generated, and (even more important) how it may be broken and new pathways generated; in understanding how a cluster may shift from evolution to involution, from expansion to contraction, from growth to decline; and in understanding how clusters generate increasing returns through a focus not just on their supply-side dynamics but on how they grow the market for their collective activities. Strategic notions like collective efficiency, the building and capture of increasing returns and the formation of

higher-order capabilities, together with other notions that make sense at the meso-level, are simply passed over in silence by the neoclassical paradigm with its endless absorption in (comparative static) equilibrium to the exclusion of almost everything else. When dealing with clusters, the comparative static approach to equilibrium needs to give way to the dynamic conception of an 'evolutionary stable equilibrium' when no further linkages can be generated between network partners that would generate a profit; and proving the existence of such evolutionary stable equilibria, under different conditions governing the evolution of clusters, may be expected to emerge as the 'holy grail' of evolutionary-oriented cluster analysis. The gains involved for the firms themselves, and for the districts, regions and countries in which they operate, are so overwhelming that investment in this kind of scholarship must pay handsome rewards. The study of industrial clusters appears to be a promising line of inquiry, as the suprafirm structures within the economy begin to attract as much analytical attention as firms and markets themselves.

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