FROM GORDIAN KNOTS TO GROWTH NODES: REORIENTATION OF GEOGRAPHICAL CLUSTERS OF FIRMS AND INNOVATION

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Abstract

Earlier models of fast-growing geographic clusters of innovative firms have argued that these tend to experience an evolutionary pattern of rise and fall. Initially, economies of agglomeration, institutional forces, and cognitive frameworks of managers create an innovative environment. Over time, those same forces create a homogeneous macro-culture that suppresses innovation, making clustered firms more susceptible to environmental jolts than nonclustered firms. This paper explores the benefits and costs of attempts to reorient geographically clustered firms and their immediate industrial and regional surroundings in Finland's Tampere region with a proactive integration of new information and communication technologies (ICT). The paper identifies opportunities for agency: the creation of global ICT-links to other firms and clusters, universities, and research laboratories work against a homogenized macro-culture, fuel an innovative milieu, and manifest transformation. Implications for technology introduction, economies of agglomeration, social and institutional reform, and further research are given.

INTRODUCTION

According to legend, Gordius, the king of Phrygia, tied a knot so difficult to disentangle it was said that the one who could do it would be capable of ruling the whole of Asia. Alexander the Great, then a young man, first tried to solve the intricacies of the knot like many others. Finally, he gave up solving the problem on its own terms, and cut the knot open with his sword. The legend is commonly held to carry the lesson that some persistent problems which appear insoluble on their own terms are soluble after one manages to think beyond these terms.

One persistent problem, insoluble on its own terms, that has been identified in the literature is the problem of "hot spots and blind spots" (Pouder & St. John 1996). Fast-growing, innovative, geographically clustered collections of firms turn into "blind spots" (Porter 1990). "Once a super nova for state-of-the-art innovation, the hot spot quickly becomes an industry black hole" (Pouder & St. John 1996).

Hot spots have many advantages, but also disadvantages, in terms of regional welfare and systems of innovation. In the first instance, the Scientific City in France and the medical instruments industry in Tuttlingen, Germany have made surrounding regions prosper. The

biotechnology and communications industries in San Diego and the computer manufacturing and computer chip industries in Austin, Texas have done the same in the United States. In the second instance, *former* hot spots in Europe, such as the Ruhr gebiet in Germany or the coalmine regions in Britain have experienced economic devastation after a slowdown in their industrial growth and economy. More recent growth regions such as Route 128 in Boston (minicomputers) and the Minneapolis area (mainframes) have also initially been innovative and grown dramatically. In a pattern that is strikingly common around the world, their fast growth and unique innovation first experienced a slowdown, and then an intense reversal, so that the region has drastically deteriorated.

Besides the fact that hot spots are an interesting phenomenon as such for research, policy makers are obviously in search of prescriptions about how to deal with the fact that some of the factors drawing firms to a particular growth location or region are the same factors that ultimately cause their exit. Much has been made of the potential of : information and communication technology (ICT) ” to enable a despatialization of economic activity (see e.g. Information Society, eEurope 2002), but so far systematic analysis of how policy can stimulate European growth by taking advantage of the characteristics of ICT is lacking (Mansell & Paré 2002).

In this paper, we review literature on hot spots and other geographical locations and clusters of firms in an attempt to disentangle the problem of hot spots and blind spots. The aim is to prescribe policy interventions, and identify new research issues as to why and how to deal with regional development, with a special focus on the ability of ICT to sustain or reorient former growth and innovation locations.

On the basis of a review of available literature, we first identify theoretical foundations for analyzing the phenomenon, and define our concepts: hot spots, geographical locations, technopoles, growth poles, and growth nodes. We then present our theoretical model of why an experience and momentum of intense growth in a geographical cluster of firms ought to lessen their preparation for an eventual turn of fortune with jolts beyond the discretion of the regional field. Thirdly, we present seminal evidence from Finland to develop a model of how, when, and to what extent change can use the loose coupling of diverse streams of ICT within globally networked firms, economies of agglomeration, and institutional forces to both break the institutional and cognitive convergence in a geographical location and to trigger the reorientation of firms in that location. Finally, we outline a research program to explore why and how investments in ICT to complement extant transportation connections and face-to-face interaction can support regional policies of incubation or intervention to bring about institutional reform and cognitive reorientation of managers of firms, users, as well as the region as a whole.

GEOGRAPHICAL CLUSTERS OF GROWTH AND INNOVATION

Generally, clusters of firms play an important role in regional competitive advantage and innovation (Steinle & Schiele 2002, Antti Kasvio 2002, Porter 2001). Researchers in such traditionally unconnected research streams as industrial organization, organizational research, and economic geography have documented benefits, costs, and dynamics that go with the clustering of firms in geographical, industrial, or other such spaces (Steinle & Schiele 2002;

Hargadon forthcoming; Pouder & St. John 1996; Lomi 1995; DeNoble & Galbraith 1992; Bania, Calkins, & Dalenberg 1992; Maarten de Vet & Scott 1992; Melecki 1985; Porter 1990; Rees & Stafford 1986; Saxenian 1994; Scott 1989).

Theoretical foundations

Pouder & St. John (1996) have developed a model for studying the behavior of geographically clustered groups of competitors within a larger industry population. Their model draws on an array of earlier research, from punctuated equilibrium and innovation (Gersick 1991; Tushman & Romanelli 1985), to organizational ecology (Aldrich & Fiol 1994; Baum & Mezias 1992; Hannan & Carroll 1992; Hannan & Freeman 1977, 1989; Lomi 1995), economic geography (Bania et al. 1992; Scott 1992), industrial organization (Porter 1980, 1990), institutional theory (Aldrich & Fiol 1994; DiMaggio & Powell 1983; Oliver 1991; Powell 1991; Zucker 1983), and cognitive theories (Kielser & Sproull 1982; Nisbett & Ross 1980; Porac, Thomas, & Baden-Fuller 1989; Reger & Huff 1993).

On the basis of their review, they conclude that economies of agglomeration which initially draw firms together eventually erode. The competitive strategies of firms in the early phase of convergence are highly innovative only as long as "the net benefits to being in a [given] location together with other firms increase with the number of firms in the location" (Arthur 1990: 237). The strategies tend to be less innovative over time: firms begin to define their field of competition as the hot spot to which they belong, rather than as the total industry population. This limits the firms' access to new ideas in their extraorganizational context, weakens their ability to innovate, and adversely affects their performance. The hot spot turns into a "blind spot" (Porter 1980: 59; Zazac & Bazerman 1991). Thus, Pouder & St. John sum up by noting that geographically clustered firms will likely move through three evolutionary phases that pattern the punctuated equilibrium model: (a) origination of the cluster and emergence of the hot spot identity, (2) convergence of clustered firms, and (3) hot spot failure. In each phase, *resource economies*, *cognitive frameworks*, and *institutional processes* may play a part in influencing competitive behavior and levels of innovation. Diverse streams of face-to-face interaction contribute as much to cognitive and institutional processes of convergence and failure as to the techno-economic organization of clusters of firms and their immediate surroundings.

We continue the work in this research stream to "specify more fully the significance of localized competitive processes for population dynamics and organizational evolution" (Baum & Mezias 1992: 599, Pouder & St. John 1996; see Porter 2001, Kasvio 2002). Van de Ven and Poole (1995) posit that more than one generative mechanism of change - such as the three phases of resource economies, cognitive frameworks, and institutional processes above - can operate simultaneously. Their typology repositions punctuated equilibrium as the interplay, rather than the mutually exclusive operation, of two kinds of time-dependent change: competitive selection (convergence) and purposeful managerial enactment (reorientation). We will take the conceptual clarity and orderly presentation of this overlapping two-phase model by Van de Ven and Poole as our starting point.

In the research tradition of Pouder & St. John and Van de Ven & Poole, we work in this paper towards exploration of how and why strategists tend to advocate the proactive introduction of new information and communication technology (ICT). Earlier research has either explained why new hot spots or geographical clusters of economic growth of technological innovation

decline (Pouder & St. John), old technopoles or geographical agglomerations of talent thrive (Castells & Hall 1994), or new growth nodes appear (Pouder & St. John 1996; Castells 2002). First, we attempt to bridge the gap of how new growth nodes might be economically sustainable positions, rather than necessarily experiencing a pattern of rise and fall. Second, we will attempt to work towards further research not only in terms of improved empirical specification, but also in terms of broadening, deepening, and testing of why, how, and when firms that cluster on the basis of their potentially global linkages on the basis of ICT rather than only on the basis of their geographic location pull other organizations in their surrounding environment into a process of growth.

Definitions of Some Key Concepts

At least in the developed countries, globalization is a process of flux in which core activities in the economy, in media communication, in science and technology, and in strategic decision-making are linked worldwide in real time by virtue of telecommunications, information systems, and electronically based, fast transportation systems (Held et al. 1999; Bell 1999). Globalization in this sense is not a process driven by one single dominant center such as Rome, London, or Washington during the peaks of geopolitical dominance of Roman, British, or American rule, respectively. Core activities still cluster, but now cluster around several large metropolitan areas at once (Castells 2000). New York, Tokyo, and London – these metropolitan areas are some of the most important of the "technopoles" (Castells& Hall 1994) in this world. They are near concentrations of experts, universities, and high-technology corporations. Professionals concentrate in these geographical areas because they require services, such as entertainment and culture, universities and schools, and community. Thus, despite the general trend of globalization, most activities actually take place in a local or regional setting (Porter 1990, 2001).

Within this context, firms distribute their technological and organizational ability across more than one location while maintaining unity of their activities with telecommunications linkages, microelectronics based precision, and flexibility in the fabrication of components. High-technology firms, in particular, tend to follow a logic whereby they distribute their manufacturing processes across different locations: at or near large metropolitan areas, they perform tasks demanding a highly-skilled, science and technology-based labor force, while at the periphery they perform routine assembly and auxiliary operations operable by masses of unskilled workers (Castells 2000).

While many of the technopoles are metropolitan areas like New York, Tokyo, and London, sometimes it is the most unlikely sites which become central nodes. Established because of a historical specificity that ends up centering a given network in a particular locality, new central nodes attract talented labor and other resources from around the world (Castells 2000), becoming regional "growth poles" (Gordon 1994). Thus, localized agglomeration, far from constituting an alternative to globalization and de-clustering, becomes the principal basis in a global network of regional economies (Gordon 1994). Growth poles are "urban locations, benefiting from agglomeration economies, and should interact with surrounding areas spreading from the core to the periphery" (Mayhew 1997).

The "new industrial space" (Scott 1989) is a complex network with more than one central "node" (Castells 2000); that is, a geographically proximate complex organizational system of

learning and economic activity, globally networked with other systems and enabled by the effective use of information and communication technologies (Mansell & Paré 2002). A "growth node" is linked to one or several technopoles and other growth nodes with modern telecommunications, microelectronics, and technology-enabled fast transportation. Rather than being part of a single unambiguous hierarchy of a center or hub and a periphery, as was perhaps still the case only fifty years ago (see Djelic 1998), it is part of a multitude of different hierarchies built into the global economy, many of these with different central nodes.

Overview of the Theoretical Model

Summing up the foregoing review of the dynamics and conceptualizations of the rise and fall of regional clusters of firms, any kind of a growth region (a) is driven by one or several start-up firms that, (b) as a group, grow more rapidly than other industry participants (sales and employment levels), and (c) develop immobile physical configurations in the long run (Porter 1990). In this view, geographically clustered high-growth firms almost deterministically undergo an evolutionary process, which tends to have a negative impact on innovation in the long run (Pouder & St. John 1996).

In contrast, thanks to advances in telecommunications, microelectronics, and electronically-enabled fast transportation, or ICT for short, each growth node is increasingly fast and the amount of links is increasing. Each growth node is a modern growth pole linked to technopoles and other growth nodes with new information and communications technologies. Each node, to be included in the network, requires an adequate local technological infrastructure, a system of ancillary firms providing support services, a specialized labor market, and a system of services required by the professional labor force (Castells 2002). To both drive and affect the habitus of a successful growth node it is important that technologies are constantly updated, that there is sufficient cultural infrastructure for the demands of professionals, that the node does not turn too much into itself, and that the node does not fail to link with one or several technopoles and other nodes in the network.

In the first phase of this kind of ICT-based growth, innovations are new products or services, new processes, and new organizational structures that firms use to compete with one another over customer demand. The adoption of the idea, process, product, or service in the firms' external environment makes success a function of the firms' technical, strategic, and administrative skills (Abernathy & Utterback 1978; Nelson & Winter 1982). The result is the development of core competences, ideally suited to the competitive landscape. In the second phase, if and when there is eventually a global environmental jolt that destroys the competitive advantage of the firm, these core competences would be destroyed and turned from competitive advantages into competitive disadvantages (Anderson & Tushman 1990), due to "lock in" (Levinthal 1994), core rigidities (Leonard-Barton 1995), and organizational inertia (Hannan & Freeman 1989), if it were not for the benefits of modern ICT.

There is a need for two kinds of basic research to understand rise and fall patterns. On the one hand, as Scott (1989: 91) has noted, "the question of the initiation and early consolidation of growth centers in capitalism (from l9th century Lancashire to Henry Ford's Detroit to Silicon Valley) has never really been satisfactorily addressed or resolved" (Scott 1989: 91). On the other hand, while there is clearly a need to study historical processes of convergence and reorientation that still may hold, it is equally important to study those possibilities and demands

that are unique to new information and communications technologies, which may allow divergence from historically deterministic paths of regional development.

Innovation in organizations is subject to individual, organizational, and environmental influence (Damanpour 1991; Levitt & March 1988; March 1991). Most studies have focused on the individual and organizational factors that play a key role in the ability of an organization to adopt innovations, while the role of the "extra-organizational context" (Van de Ven 1986) in innovativeness has often been understated. The extra-organizational context is a social system that governs, integrates, and performs all of the functions required to transform technological innovations into commercially viable products (Pouder & St. John 1996). Rules of the game in such a system are global and emerge over time through a process of accumulation (Djelic & Quack forthcoming).

In the global extra-organizational context, while the rules of the game, on the average, accumulate in the long term, there can be considerable flux in cognitive understanding of the rules in the short term. Perceptions of *what* rules are emerging and *why* are neither constant nor always changing in a way that is controllable. Under certain conditions, clusters will behave as a subpopulation of their extra-organizational context and will have similar resources, cost structures, cognitive frameworks, and competitive behavior as their larger industry population. Under other conditions, they will have tightly interdependent rates and areas of innovation that are different compared to those of the larger industry population. During environmental jolts, the firms within the clusters will reorient towards or away from the larger population (Tushman & Romanelli 1985; Pouder & St. John 1996), according to whether the jolt is competence-enhancing or competence-destroying (Anderson & Tushman 1990).

Earlier studies have developed models of subpopulation evolution using the organizational evolutionary stages described in the punctuated equilibrium model (Tushman & Romanelli 1985), the idea of deep structure (Gersick 1991), and interaction between a firm's behavior and its local institutional surroundings (Pouder & St. John 1996).

The punctuated equilibrium model highlights the interaction between a firm's behavior and the extra-organizational context. This model is generally informative about how alternating periods of cooperation, convergence, and competition co-evolve with economic performance and the average rate of innovation.

Deep structure initiates and sustains patterns towards and away from mutual convergence. A deep structure is a local "network of fundamental interdependent choices of the basic configuration into which a system's units are organized, and the activities that maintain both this configuration and the system's resource exchange with the environment" (Gersick 1991: 15; see Granovetter 1985). The presence of a geographic cluster reinforces resource arrangements, cognitive frameworks, and patterns of collaborative and competitive behavior that serve to recreate and sustain mutually interdependent choices and activities within the geographic location more than they directly impact upon innovation or competitiveness. At least in the past, the underlying commonalties have caused geographically clustered firms to behave more like each other and to assess competitor and market trends similarly (Djelic & Ainamo 1999; Guillén 1994; Haveman 1993).

The result of the interaction of the extra-organizational context, the local deep structure, and firms' behavior can be two separate evolutionary paths for clustered and nonclustered competitors. On the one hand, some firms with mutual interdependencies initially cluster to

experience resource-cost and access advantages, heightened competitor awareness, and collective industry dominance in terms of growth and innovation, leading to enhanced legitimacy and hot spot identity. Over time, these clusters begin to experience pressures to develop insular competitive practices, less frequent innovation, and resource diseconomies. These experiences make the cluster vulnerable to naive industry assumptions, imitative behavior, and unproductive innovative efforts, and a process of economic deterioration (Pouder & St. John 1996). On the other hand, other firms that are not similarly clustered experience diseconomies initially, but may improve their positions as the resource and cognitive costs of clustering become apparent (Pouder & St. John 1996).

Thus far, few studies within or outside the punctuated equilibrium model have specified why non-clustered firms could act as drivers of reorientation of geographical clusters, or how they interact with clustered firms. For the purpose of contributing to filling the study gap, macro-views of dynamic processes of convergence and reorientation of geographical clusters of growth and innovation can be culled from such research streams as punctuated equilibrium, institutional theory, and urban sociology (Hannan & Freeman 1989; Castells 2002). Micro-views can be culled from such cognitively oriented views as small groups and communities (Brown & Duguid 2000; Hargadon forthcoming; Mansell & Paré 2002; Kelley 2002), theories of organizational innovation and learning (Levitt & March 1988; March 1991), and models of information systems (Davenport & Short 1990; Hammer & Champy 1993). In between or spanning across macro and micro views, various theories of coevolutionary process and systems theories exist (Mansell 2002; Max Boisot [e.g. C-space]; Ainamo & Pantzar 2000).

For the purpose of culling a seminal model of convergence and reorientation of firms and their immediate surroundings through access to global networks, learning about these in practice, and being able to put these ideas and practices into use, we present seminal Finnish evidence collected in the city of Tampere and its immediately surrounding region. The evidence suggests that a geographically nonclustered firm can initially experience diseconomies, but improve its position over time. Second, the evidence suggests that such a firm's model can diffuse with the firm's success, when the resource and cognitive costs of clustering become apparent for the clustered firms.

SEMINAL EVIDENCE FROM FINLAND AND TAMPERE

In the mid-1980s, most Finnish firms were oriented towards the Soviet Union. While having the foot of many of its divisions firmly in Soviet trade, Nokia Corporation began to reorient with mobile telephony and consumer electronics towards Western markets. Nokia's management began to distance their firm institutionally and cognitively from the other, geographically closely clustered Finnish firms, while also trying to mobilize other Finnish firms to follow them.

With the fall of the Soviet Union, it turned out that Nokia's management had correctly predicted a need for reorientation. However, Nokia had failed almost critically in their predictions of time spans. By jumping head first and aggressively into the exploration and appropriation of new information and communications technologies, it was only from the brink of bankruptcy that Nokia attracted global financial investors and avoided bankruptcy in the early 1990s.

With the fall of both the Soviet Union and Soviet trade for Finnish firms, the Finnish economy as a whole deteriorated. In stark contrast to the rest of the economy, Nokia was able to receive injection of global financial capital to make a spectacular rise into a global firm from the mid-1990s. It soon became a model for other Finnish firms (Ainamo 1997). By the turn of the millennium, institutional pressures both outside and within Finland began to work against Finnish firms that were still entrenched in the old institutional order and out-moded cognitive frameworks (Tainio et al 2002).

Tampere is the center of one of Finland's oldest regions, where Nokia Corporation also traces its roots. Nokia had long since moved its headquarters to Helsinki but in the 1990s, Nokia grew its strong local presence by employing thousands of new employees. In contrast, by the late 1990s it was becoming clear that the same could not be said for the region's traditional forest-industry and other manufacturing firms, which employed less and less people. The city was effectively becoming a "dual city" with growing unemployment in large "manufacturing industrial firms" requiring little education from workers, and nationally but not globally large "ICT firms" in telecom service operations, such as Sonera, Radiolinja, and Soon, as well as Nokia, a global ICT firm. All of the ICT firms benefited from the pool of highly educated people in Tampere, with its two universities (Tampere University of Technology and the University of Tampere).

Within this context, encouraged by a-priori knowledge of European Commission initiatives (Information Society Forum; eEurope 2002), city strategists and university representatives in Tampere decided in 200 to reinvent the "Nokia model" at the regional level (Kostiainen 2002). These strategists refrained from direct policy interventions so as to encourage large manufacturing firms in the region to retain initiative. At the same time, in what they called the "eTampere" inititiative, they began to introduce new information and communications technology to build regional infrastructure and to incubate new ICT firms.

The local large manufacturing firms and all of the large ICT players (Nokia, Sonera, Radiolinja, and Soon) remained mostly neutral to the eTampere inititiative. The result was that a few small telecommunications, information technology, and other such ICT firms that existed in the region received disproportionate media attention in relation to their economic importance in terms of extant size and sales.

At the time of writing (October 2002), after two and half years of experience with the intiative, it is still too early to say what will be the ultimate effect of the eTampere initiative for the immediate geographic surroundings or local firms, on a grander scale, globally networked firms, universities, other research institutions, and communities with which they also cluster. As of yet, many of the new technologies have not been fully successfully channeled into the routines of firm.

The global slowdown in the information and communications industries has meant that the initiative has not been able to successfully create an atmosphere of excitement and entrepreneurial-minded optimism. Nonetheless, local new economy firms in the Tampere region, as elsewhere, tend to attract and employ young educated people. The eTampere initiative has already become a symbol of a paradigmatic crossing from a locally clustered orientation to a more global outlook in terms of regional policy and practice.

The eTampere initiative has successfully detracted attention from the fact that the traditional manufacturing industry sector has continued to employ decreasing amounts of labor. In a

national poll in 2001, Tampere was voted the "most popular" city in Finland, judged both on the basis of the working environment and the vivid cultural life. The votes came from across Finland, and across age groups. Without eTampere, young people, in particular, might have only perceived opportunities in the poorly paid service sector. Now they have flocked in even larger numbers than ever before into the city's two universities (Tampere University of Technology, University of Tampere), as well as to work for Nokia. With young, mobile people moving into the city, becoming highly educated and professionalizing, and further contributing to the vivid cultural life, the city embodies all the characteristics of a regional hot spot.

Within this context of reorientation, the Tampere has been an important vehicle in the creation of new interdependencies with the global extra-organizational context, in encouraging regional institutional reform, and in the reorientation of cognitive frameworks of regional managers and other key stakeholders. The initiative has become a model for initiatives in other regions that aspire to reorient their systems of industry and innovation, both in Finland and abroad.

While the initiative has in many ways been less than an initiative planned, implemented and controlled decisively, this very ambiguity has perhaps been its strength, at least this far, for policy makers in other cities and regions within and outside Finland.[1] Many of the seminal developments in these loosely coupled areas of reorientation in the journey toward new convergence are as of yet unconnected, but the architecture of reorientation has served to open up the Tampere region to connections with the world's technopoles and other growth nodes. The eTampere strategy has been to emergently grow an open and flexible architecture in terms of the reorientation this time around, as well as in terms of future reorientations.

CONCLUSION

The problem of uncontrolled rise and fall patterns in fast-growing regions has been a Gordian knot that has provoked us to review theories from the levels of individual manager, firm, collectivity, and industry, and to show why and how geographically clustered competition can affect innovation over time, and vice versa. Rather than assume, as some theorists have, that processes of convergence and reorientation in the structure of an industry simply unfold (Meyer et al. 1990), we have tried to specify mechanisms for such changes (Pouder & St. John 1996). Our model of regional reorientation extends earlier models of punctuated equilibrium and spatial competition theory towards room for agency with the help of new ICT.

Through our focus on a matrix of the pacing and processes of reorientation, firms inside and outside of the cluster, and perceived success versus failure, we have sought to forge connections between advances in ICT and those in institutions and cognitive frameworks. The basic idea that emerges from our seminal evidence from Finland is that, rather than having only an instrumental purpose, the introduction of ICT reframes the coevolution of firms and their immediate surroundings, *not* as deterministic, but as opening up cognitive and institutional avenues for reorientation.

[1] "Properly partnered with five or similar initiatives from other countries, you [that is, G-NIKE, the research network as a whole] can expect a EUR 15 to 20 Million budget from the European Commission. There is a need for the existence and study of these kind of large initiatives that combine the interests of policy, industry, and research", commented an official of the European Commission to us. Other Commission officials and Directors provided similar encouragement to our G-NIKE project.

One of the two central themes in this paper has been to identify how policy intervention can escape or treat economic losses and return firms to high levels of innovative activity as rapidly as possible following an environmental jolt. The other theme has been to identify avenues for future research.

Prescriptions for Policy Interventions

Fast growing geographical clusters of firms and innovation have through the ages turned into Gordian knots of economic devastation. In addition to explanatory and descriptive research on regional locations, policy makers and strategists obviously wish for prescriptive models of successful reorientation. These wishes pertain to how, precisely, a policy maker can initiate organizational-development efforts with ICT that modify organizational culture and lead to restructuring activities that refocus firms' competitive priorities, attract firms and human resources, and provide enough leverage for globally networked suppliers, new sources of technical and skilled labor, and re-locations of firms to promote regional welfare and equity.

On the basis of the seminal evidence in this paper, investments in information and communication technologies, by bridging conventions inherited from the past and visions about the future, help to contribute to successful reorientation, increases in welfare, improved equity, and the development and strengthening of Pan-European identity (Information Society Forum, eEurope 2002).

More specifically, on the basis of our seminal evidence, the investments in ICT have four advantages. Firstly, investments in ICT give a regional innovative pioneer a medium by which to access new ideas from the outside. Secondly, they give these pioneers a platform from which to interact and to develop new ideas and practices in cohort with others.

Thirdly, the investments are sufficiently tangible to act as exemplars of a paradigm shift in the making. The investments promote both discussion and dissemination of new ideas and practice to other individuals and groups outside and within one’s own geographic location. Finally, the investments in infrastructure provide evidence to regional community members that policy makers will not let a dual city institutionalize.

In sum, it appears that the successful reorientation of one leading entrenched firm can reorient a geographic location as a whole in two overlapping phases: (1) geographical clustering, convergence, weakening of the economic viability of the local firms, and the threat of the geographic location as a whole, and (2) economic and innovative reorientation of the geographical location with the help of a model based on the example of a leading firm and the introduction of new information and communication technologies.

On the basis of the review of literature and the seminal evidence from Finland and Tampere, it appears that ICT investments are proof of that intent, as well as of resources “already” flowing to the firms from outside the cluster, even while reorientation may have not yet been fully achieved. If this conclusion is valid, ICT infrastructure is potentially in a critical role to build a region into a growth node, and sustain it as such.

Thus, in this paper, we have developed a model of reorientation of geographically clustered firms that, at least in the case of the Tampere system of firms and innovation, has served to balance the failure of persistently clustered firms with access to new ideas, adaptation to new

and emerging contingencies, and preparation for major jolts in development. This model may be transferable to geographical locations beyond Finland.

There is a need for further research to reach findings that aid policy makers to understand why and how to balance deep structure and diverse streams of ICT with infrastructure. Policy makers ought to support researchers who will help them recognize the Gordian knot: close interdependent connections between economic and cultural decline appear to involve insurmountable institutional and cognitive pressures, but are not impossible to disentangle if one thinks "outside the box".

Implications for Theory and Research

The model presented here links three previously separate research streams that can be viewed as some key areas for future work: (a) punctuated equilibrium theory, (b) geographically unique and global growth nodes, and (c) various rationales of reorientation.

Our model provides at least *three avenues for future research*. First, and most basic, the model invites theory-building research directed toward *broadening and deepening explanations.* We have cross-pollinated between theoretical ideas and empirical evidence to argue that geographical clusters are a particular case of globally networked organizational fields, with room for agency. In the instance of reorientation, the foregoing matrix of why and how geographical clusters of firms reorient their immediate surroundings as a whole from the perspective of local rationality points toward a theoretical lens, for example, in organizational innovation, learning, and fields (Levitt & March 1988; DiMaggio & Powell 1983). Greater attention to modeling causal links between cognitive, institutional, and symbolic processes than what we have been able to present here is required. Within this context, institutional theorists might focus on the institutional leadership roles that individual and social actors –as strategists and users—act in innovation (Jennings & Zandberger 1995; Hargadon forthcoming; Mansell & Paré 2002). To what extent are regional reorientations successful through random versus predictable processes? To what extent is it important that growth nodes are not only magnetic attractors but also propellers of new ideas and practices? Analysis of non-linearity and chaotic processes, both in quantitative and qualitative terms, may offer answers (Simon 1996; Van de Ven & Poole 1995).

The second avenue of research is in response to some of the difficulties inherent in studying development in regional and other geographic locations. Such difficulties include *determining and specifying* cognitive frameworks of strategists, agglomeration economies, and institutional forces over time. Interdisciplinary empirical findings may allow researchers to answer long-standing questions. A promising approach is multiple parallel case studies where researchers could use the same protocol for collecting data and assessing patterns over time within each industry unit of analysis (Eisenhardt 1989; Yin 1984). Combining such knowledge into the knowledge bases from the first avenue of research, above, would result in information very useful to diverse policy makers.

The third and final avenue for future research suggested by our model of growth nodes is *theory testing* within and across regionally and cross-regionally determined boundaries. By studying managers and firms, the role of ICT, and regional and cross-regional fields, strategy researchers could address questions concerning the definition and evolution of strategic groups. Cognitive researchers could study the link between managers' cognitive frameworks of

competitors and homogeneity in innovation strategies of firms (Abrahamson & Fombrun 1994; Prahalad & Bettis 1986; Spender 1989). These and other researchers might construct indicators of institutionalization in innovation strategies over time using methods to evaluate bandwagon effects across clustered competitors, cumulated over time (Abrahamson & Rosenkopf 1993).

The above three research avenues flow from both earlier research in the rise and fall of geographical clusters of growth and innovation and our seminal evidence. From a research road map perspective of how to get from here to there, there are two obvious avenues to consider. The first is to begin with a deepening and broadening of what kind of contexts, inputs, processes, or outcomes are involved and why and how these possibly interact. The second avenue is to focus on specifying some of the processes that lead to or from one or the other of these variables. It would appear that only after seeing through one, the other, or both of these avenues does it make sense to test theories that we have formulated through the other avenues. The evidence suggests that the data cannot be directly coerced into "one best way". Gordian knots are not soluble on their own terms, but require thinking outside the box.

This said, researchers can obviously begin to define their research setting, not as we did – with the persistent problem that geographically clustered firms tend to experience a rise and fall pattern – but with some other problem or solution. Mansell & Paré (2002, see Brown & Duguid 2000; Hargadon forthcoming), for example, begin the development of their model with the persistent problem that users are not always eager to experience new ICT without having recourse to older models of product concept and ways of use.

The relationship of ICT and growth nodes represents a landscape in which many kinds of road maps for research and policy may be equally valid. Going back to our story of Alexander who opened an otherwise insoluble knot by cutting it in half by force, most of us differ from him in that we do not want to cut in half cities and regions we really wish to unite. Problems in policy implementation or research processes cannot always be handled by force or coercion once they have already emerged. And, to avoid problems in the first place, travelers tend to agree that one is less likely to end up in dead-end alleys or making detours when one has a map of some kind. That is why there is a need for research broadening, deepening, determining, and specifying our knowledge of regional systems of business and innovation.

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