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## Small Technology-based Firms in a Fast-growing Regional Cluster

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*Small technology-based firms (STBFs) are increasingly emerging into regional clusters. While these clusters provide the necessary resources and market opportunities, they are also, like the firms themselves, subject to an evolutionary cycle from origination to convergence and reorientation. The evolutionary framework suggested in this article provides a frame of reference for relating the behavior and development of clustered STBFs to their environment. Three critical factors related to the evolution of clusters and STBFs are discussed: resource shortage, internationalization, and heterogeneity of firms.*

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**D**evelopment forecasts for technology-based and high-technology firms have been, and still are, quite favourable throughout Europe and the United States, giving rise to great expectations as to their role in economic development. In the belief that small firms, in particular, could provide growth, employment and wealth, local and regional authorities and other governmental bodies, have invested or are planning to invest in developing, attracting, and fostering STBFs. The rationale for the investments is the hope of creating a cluster or network of competitive technology-based firms locally or regionally. This trend in regional development activities can be seen particularly in Europe. However, the process through which such regional clusters develop remains unclear not only to regional authorities and investors but also to the entrepreneurs operating in such regions.<sup>1</sup>

Despite the expectations placed in STBFs, however, both research and simple observation suggest that initially fast-growing regional clusters of competing and competitive technology-based firms go through an evolutionary cycle from origination to convergence and reorientation (i.e., from growth to decline).<sup>2</sup> Thus, more detailed study of this process is warranted in order to evaluate whether the expectations placed in STBFs are not, in fact, misguided, and to analyze the conditions that might affect the decline, or otherwise, of regional clusters.

A regional cluster is defined as an aggregate of firms operating within the cluster throughout their life cycle. The development of regional clusters hinges on the presence of

universities, research institutes, science parks, businesses and entrepreneurs, and attractive residential environments in providing the basis and resources needed.<sup>3</sup> The role of entrepreneurs is of particular importance and should be reflected accordingly in any attempt to understand the role of STBFs in regional development.

In the starting phase of a regional cluster, firms experience resource cost and access advantages, heightened competitor awareness, and enhanced legitimacy.<sup>4</sup> Within the cluster, firms tend to define their field of competition largely in terms of the regional cluster they belong to rather than the total industry population. This kind of restricted perspective concerning their operating environment may ultimately be responsible for the demise of the firms and the cluster in the form of limited innovative potential and decreasing performance. Also, the carrying capacity of the region—in terms of available resources—may reach its limits before the market opportunities are fully exhausted. By contrast, internationalization and globalization may affect the firms in positive ways by expanding market opportunities and broadening the perspectives and networks of the firms.

The question arises as to the role played by STBFs in the development of the regional cluster in terms of growth, internationalization, and employment. Available aggregate-level statistics cannot access this question from the perspective of the individual firm, but it is precisely the firms themselves that are the engines for developing the desired positive results. To understand the processes of growth of STBFs within their clusters, it is essential to study their actual behavior—both at the level of the individual firm and at the aggregate level. However, since the development of STBFs seems to take place on a local or regional basis, another question emerges—whether the process of growth of STBFs within clusters or networks of firms differs in some way from the development of the overall industry outside the clusters. Thus, one needs to focus on the special environmental characteristics and phenomena related to fast-growing clusters in order to assess the role played by STBFs in the dynamics of regional development.

In general, STBFs can be seen as embedded in their environment and operating networks as they develop on a regional or a local basis.<sup>5</sup> Embeddedness has been defined

in the context of small- and medium-sized technology-based firms as the strength, intensity, and permanence of links between firms and their operating environments, regardless of whether these operating environments or networks are local, regional, national, or international in nature.<sup>6</sup> In the case of growth and internationalization from a regional basis, embeddedness entails the strengthening of existing relationships and the emergence of new relationships between the actors in the network.<sup>7</sup> Typically, STBFs need to mobilize external complementary resources, knowledge, and market channels through other firms to maintain and/or expand their operations.<sup>8</sup> For STBFs, the development and internationalization of the firm is largely defined by technological linkages,<sup>9</sup> business linkups, and innovation.

This article provides a frame of reference for understanding the development of fast-growing regional clusters from the point of view of STBFs, using the region of Oulu, Finland, as an example. In particular, this article examines the growth, internationalization, and development patterns of STBFs from the perspective of the individual firms and the region as a whole. The analysis presented refers to the 1992 to 1998 time period.

## Research Methodology

In view of the embeddedness of STBFs, traditional dyadic business-to-business relationships are not sufficient as a unit of analysis even at the level of the firm, let alone at the regional level. Thus, the scope of the research must be broadened to cover the whole set of interdependencies and relationships of the firms.<sup>10</sup> To study the process of development and internationalization within the regional contexts of firms, it is necessary to identify and examine the development processes within the specific network of each individual firm involved in the exchange and development of resource.<sup>11</sup> At the same time, these company-specific networks and development paths<sup>12</sup> must be related to the development of the whole region.

Given these starting points, this study represents exploratory research involving qualitative and quantitative aspects. Exploratory studies serve three general purposes: (1) to discover significant variables in a field situation, (2) to identify relationships among the variables, and (3) to lay the groundwork for later testing of possible hypotheses.<sup>13</sup> The present study does not involve the testing of hypotheses, but is aimed at theory development through a combination of quantitative and qualitative data that serve to widen the scope of the study.<sup>14</sup> Another reason for choosing an exploratory approach resides in the purpose of the study, which was conceptual analysis and theory-building concerning the phenomena observed in regional clusters.<sup>15</sup>

The research process included four stages: (1) literature

review, (2) analysis of quantitative data, (3) analysis of qualitative data, and (4) developing conclusions. The *Oulu Business Review* (OBR) database<sup>16</sup> provided the data for the quantitative part of the research. The OBR database includes information on all technology-based firms within the region with a workforce larger than five; smaller firms are included if their operations have been continuous and they have established sustainable market positions. As of March 1998, 140 technology-based firms were operating within the Oulu region. The qualitative part of the research included multiple case studies, as well as discussions with managers of technology-based firms, regional and local policymakers, and representatives of the university and other institutions involved in research and education.

Due to the strong contextual dependence of STBFs in regional development processes, the results are not expected to be directly generalizable in the positivist sense. In fact, generalization was not among the primary purposes of this study. However, it is argued that the theoretical frame of reference constructed to study the development of regional clusters and the role of STBFs can be applied equally to studies of other technology-based firms in other regional contexts and using other research methods.

## The Evolution of Regional Clusters

When analyzing the processes involved in the development of regional clusters of STBFs, issues such as entrepreneurship, networks, resources, and their role in and relationship to the regional cluster come into focus. This information is needed to understand the entrepreneurial, institutional, and international or global forces affecting the development of fast-growing, innovative regions, and especially the firms operating in these regions.

### The Context

Entrepreneurship is one of the key issues in understanding the development of regional clusters.<sup>17</sup> Since entrepreneurship can be seen as a context-dependent social process,<sup>18</sup> the characteristics of the context become important. One way to define the context is the industry, with the regional cluster viewed as a part of the total population of it.<sup>19</sup> The division between emerging, growing, and mature (or declining) industries applied within entrepreneurship research can be transferred to regions, since not only industries but also regions go through evolutionary phases of development. Poudier and St. John distinguished three phases in the evolution of clusters—origination, convergence, reorientation—that resemble phases of industry evolution. As industry boundaries are continually shifting—even faster within technology-based industries than within “traditional” industries due to the emergence of new technologies—it is difficult to

define industry boundaries. The concept of regional cluster provides a way of resolving this difficulty since the region can be considered an industry (industrial district) or a part of it. Thus, the boundaries of the industry are defined by the geographical boundaries of the cluster.

The forces affecting entrepreneurial behavior within a regional cluster include: (1) the personal networks of the entrepreneurs, (2) the activities of the entrepreneurs, (3) the motivations of stakeholders of various types, and (4) the structures and strategies of the emerging organizations within their contexts.<sup>20</sup> At the regional level, the forces affecting the evolution of the cluster include (1) resource conditions, (2) mental models of management (and entrepreneurs), and (3) institutional processes related to gaining legitimacy for the new firms and technologies in the markets.<sup>21</sup> In fact, the need for legitimacy is the reason for clustering, since firms participate in interfirm relationships to enhance legitimacy. A typical characteristic of the markets in which STBFs operate are rapid technological changes as well as technological heterogeneity<sup>22</sup> (i.e., the absence of dominant technologies). This makes it difficult for the STBFs to establish the legitimacy and credibility needed to access international markets and networks. Local, regional, and national networks, by contrast, represent an easier environment for STBFs, since they provide the basis for the initial growth and internationalization of firms. The local or regional network may provide the firms with skilled staff, needed technologies, and opportunities to supply other firms with innovative products or advanced, knowledge-intensive services. However, access to international markets is not necessarily supported by the local or regional networks.

**Phases of Evolution**

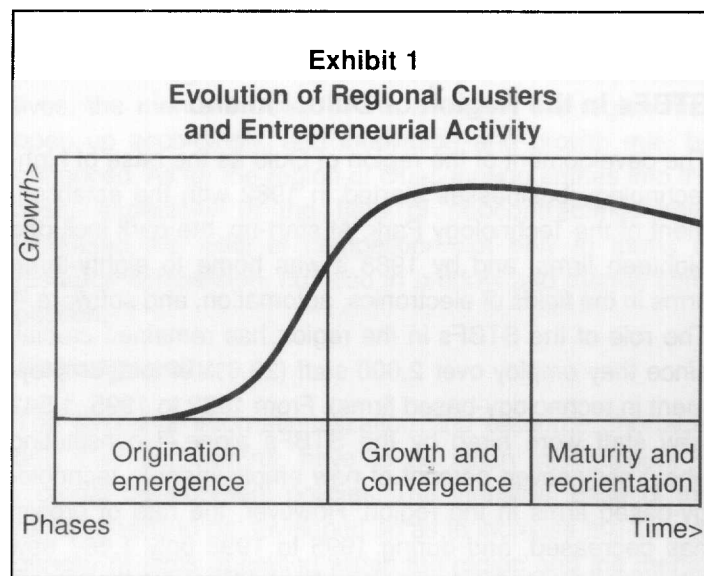
This section identifies three phases in cluster evolution:

1. Origination and emergence
2. Growth and convergence
3. Maturity and reorientation

**Origination and Emergence.** In the first phase of cluster evolution, innovative entrepreneurs utilize unique personal contacts that enable the linking of previously nonoverlapping networks. New, fast-growing firms are founded and problems related to the legitimacy of the new activity must be solved. The structures and strategies of emerging entrepreneurial activity are market-based, with collaborative elements, as externally available resources are actively used by the STBFs. With new firms entering the emerging cluster, agglomeration economies are achieved, and similar mental models evolve among the entrepreneurs and key personnel of the firms in the region.<sup>23</sup> In addition, competition could be a growing factor as businesses serve the same customers

and are, in turn, served by the same suppliers.

**Growth and Convergence.** Once the problems of legitimacy have been overcome and real growth has begun, entrepreneurial success rests with the ability to thrive in



environments characterized by rapid growth and change. This calls for extensive, high-quality networks with relatively weaker ties, as compared to the previous phase of cluster evolution, and more differentiation in business strategy to counter the effects of converging mental models of entrepreneurs and managers within the cluster, which tend to encourage imitation and homogeneity in business activities.<sup>24</sup> As imitation and homogeneity begin to take hold, the cluster enters the phase of convergence: the growth rate of the firms decreases, as does the number of new entries into the cluster.

**Maturity and Reorientation.** In mature environments, growing resource competition leads to cost increases, causing the loss of agglomeration economies. At the same time, entrepreneurial activity becomes even more conservative and imitative in nature.<sup>25</sup> If agglomeration diseconomies persist simultaneously with increased imitation and homogeneity, reflected in the strengthening and stability of ties between cluster participants, the number of firms within the cluster starts to decrease and innovation starts to occur outside the regional cluster.

Despite the pessimistic determinism of the three-phase evolution, the inevitable decline may be avoided or postponed by two forces: internationalization of networks and deliberate introduction of heterogeneity in the regional cluster and its business activities. With technology-based industries becoming increasingly international,<sup>26</sup> STBFs are well

advised to adopt a multidomestic or global approach to markets from the very start, or build specialized international networks<sup>27</sup> to overcome resource shortages and exploit market opportunities. The process of internationalization also seems to enhance the evolution of the cluster, since it adds new customer and supplier contacts and introduces diversity and heterogeneity.

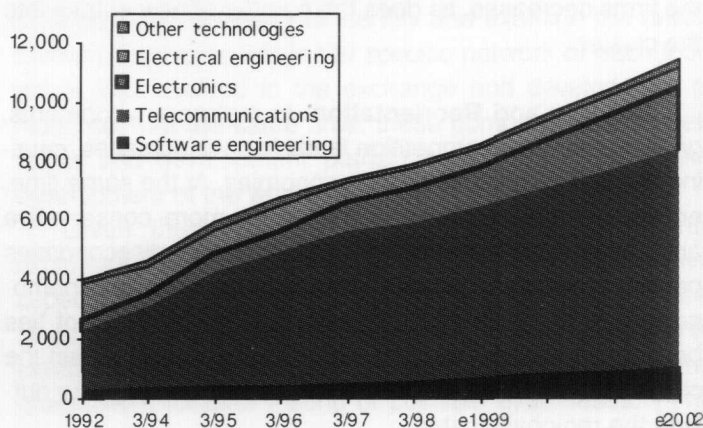
### STBFs in the Region of Oulu, Finland

The development of the region of Oulu as the base of high-technology businesses started in 1982 with the establishment of the Technology Park. At start-up, the park included eighteen firms, and by 1988 it was home to eighty-three firms in the fields of electronics, automation, and software.<sup>28</sup> The role of the STBFs in the region has remained crucial, since they employ over 2,000 staff (28.6% of total employment in technology-based firms). From 1992 to 1995, 1,542 new staff were hired by the STBFs alone,<sup>29</sup> constituting about sixty-seven percent of new employment in technology-based firms in the region. However, the rate of growth has decreased, and during 1995 to 1998 only 1,867 new jobs were created in technology-based firms *for the region*. In addition, the rate at which new firms enter the field has decreased; currently, the number of technology-based firms operating in the region stands at around 140,<sup>30</sup> only three of which can be regarded as large businesses.

Total turnover of technology-based firms operating with-

**Exhibit 2**

#### Employment in Technology-based Firms in the Region of Oulu (OBR data)



in the region is around 1.41 billion European Community Unit (1998), of which about fifty percent is exported directly. The average export share of STBFs varies according to the growth rates of the firms. The majority (55%) of STBFs in the region can be regarded as fast-growing,<sup>31</sup> with an average export share of sixty-two percent (1995). In other firms,

the export share varied between twenty-five percent and thirty-five percent of total sales.

### Resource Shortage

As a whole, the development or evolution of the Oulu region resembles that of other regional clusters for which research results are available. The fast growth in employment by technology-based firms has decreased since the early 1990s, although growth in turnover and exportation remain high. There is strong demand in the region for skilled, highly qualified staff, and the existing training provision for engineers and software developers is unable to satisfy the staffing needs of firms in the cluster. This has affected the development of STBFs more strongly than that of larger firms. As a result of businesses being short-staffed, a spillover effect is taking place: outsourcing and subcontracting are increasing within the region and beyond. Moreover, the personnel profiles of the firms are changing as the share of hardware in total sales is decreasing in favor of services.

### The Transition

Signs indicate that the region has entered or is entering the phase of convergence. Due to a shortage of resources (OBR database), especially human resources, firms seem to be focusing increasingly on the core elements of their businesses, neglecting new, potentially attractive business related to innovations. In addition, from a regional point of view, there is the danger of increased homogeneity in the industrial base of the region. However, internationalization and the entry of foreign firms into the region have been broadening the operating environments and networks of firms, especially through subcontracting, leading to changes in buyer-seller structures. This process of internationalization has also led to increased competition—a vital precondition for maintaining the innovative potential and international competitiveness of firms.

### Subcenters

The success experienced by Technology Park has led to imitation as innovation centers are being established throughout the region. Public awareness of past successes seems to have led to a situation in which future success is taken for granted. Despite the shortage of skilled personnel and other resources, the paradigm or mental model underpinning the innovation centers seems to be gaining rather than losing in influence. The proponents of the newly established innovation centers seem not to accept or be aware of evidence that these centers might not be able to generate fast-growing subcenters of innovation within the region.

## STBFS and Regional Clusters: Implications and Conclusions

As an extension to theories derived from previous research, the evidence found and the developments observed in the region of Oulu suggest four critical factors in avoiding or delaying possible negative developments in the evolution of regional clusters: global competitiveness, overcoming resource shortages, internationalization, and heterogeneity of the industrial base.

### **Global Competitiveness**

Technology-based industries are typically globally-based, which creates special challenges for regionally operating STBFS. Thus, the regionally clustered STBFS need to develop an international or a global network through which know-how and competitive resources can be acquired and combined.

### **Resource Shortage**

Problems related to resource shortages during the growth of a regional cluster were not given enough consideration by previous theorists. Increasingly, regional competition seems to be taking the form of resource competition rather than market competition. This places special demands on the authorities and institutions involved in research and the training of potential recruits for technology-based firms. Also, in the face of resource shortages, relocation of production facilities inevitably increases. In the case of Oulu, resource shortages have given rise to cooperative arrangements through which firms, universities, and other training organizations can improve the provision of highly skilled staff. In the long run, the small number of inhabitants within the region may emerge as a major problem.

### **Internationalization**

The internationalization of industries creates new competition and market possibilities. The results of this process can be seen also at the regional level, as foreign firms enter the area (through entries and acquisitions) and regional businesses relocate or establish activities outside the boundaries of the region. Due to the broadened market perspectives, the mental models of the actors of the region may open up accordingly, and innovation and growth may be enhanced. As for the region of Oulu, foreign entries into the area, especially in the field of subcontracting, have increased the level of competition not only in terms of resource competition, but also in product and market competition.

### **Heterogeneity**

The forces of internationalization and resource shortage, and their implications, have to be taken into account in regional development policies. The industrial base of the region needs to be developed so as to increase the heterogeneity of firms operating within the region and the mental models of local entrepreneurs and regional policymakers. Exaggerated homogeneity may lead to agglomeration diseconomies in important aspects of the evolution of regional clusters.

### **Conclusions**

It will be interesting to observe, in the case of the Oulu region, whether the cycle of development suggested in this article for STBFS in a regional cluster can be altered or at least decelerated through focused measures by decision-makers. Indeed, in view of the continued faith in the growth potential of STBFS, it is doubtful if the need for such measures will, in fact, be recognized and acted on.

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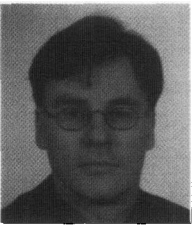
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Since 1989, Mr. Hyry has been a member of the Continuing Education Centre at the University of Oulu, where he is responsible for management training development. His research is in the area of small technology-based firms as a part of regional clusters. He participates in the Graduate School of the University of Oulu and is a member of the Northern Lights Group.



**Pekka Räsänen** graduated from the University of Oulu, Finland, in 1994, with a major in industrial management and process engineering. His master's thesis examined the engineering industry in Finland and formed part of a large research program on the competitive advantage of Finland.

Mr. Räsänen has worked as a researcher and project manager at the University of Oulu since 1995. In 1996, he coordinated a networking project for Medipolis Ltd., a concentration of companies specializing in medical technology and biotechnology, which operates as a subsidiary of the Oulu Technology Park. Over the past year, he has been managing the organizational development team at the University of Oulu's Continuing Education Centre. His research interests are in the area of small firm internationalization and entrepreneurship, with particular emphasis on biotechnology and regional development. Since 1995, Mr. Räsänen has been responsible for the Business Review of Oulu Region, a research program. He is a member of the KOLUMBUS research group.