The spatial clustering of U.S. technology IPOs

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ABSTRACT

Introduction

Spatial clusters of firms active in the same industry sector have been a dominant feature of the geography of economic activity. New innovative firms, in particular, have been the focus of much clustering research. To be successful, new firms must raise finance to support innovation and patterns of development can differ. This paper explores the role of technological innovation and venture capital on the evolution of regional clusters. New firms that go public are indicative of successful and influential innovation taking place within a cluster and contribute to further the development of the cluster to which they belong.

Cluster evolution, firm performance and finance

There is no shortage of examples of clusters[1] at different stages of development and degrees of success. Martin and Sunley (2011, p.1300) sum it up nicely: "Clusters come and go; they emerge, grow, may change in complexion and orientation, may undergo reinvention and transformation, and may eventually decline and disappear." Evolutionary economics suggests that cluster evolution may be path dependent (Nelson and Winter, 1982). Many scholars have argued that clusters may end up in regional and technological 'lock-ins', i.e. become locked into development paths that lose dynamism, whilst other regional clusters are able to created new innovative paths. Evolutionary economic geography is a relatively new field of study and many empirical questions remain unanswered. These include, What provokes path dependence? Are there several types of path dependence? Can different paths co-exist within a technology cluster? Can the recombination of legacies from past growth help avoid technological 'lock-ins'? What are the escape routes? How are new paths created? Economic geography theorists have proposed possible solutions (Martin and Sunley, 2006): i)

[1] Porter (1998, p. 197) defined clusters as geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions … in particular fields that compete but also cooperate.

indigenous creation, ii) heterogeneity and diversity, iii) diversification into technologically related industries, iv) upgrading of existing industries and v) transplantation from elsewhere.

Throwing light on the processes which contribute to both successful and to declining clusters, Martin and Sunley (2011) argued that clusters can be viewed as complex adaptive systems that can produce multiple path dependent evolutionary trajectories and unpredictable courses of change. Authors argued that some continuity in space and time is required to maintain cluster identity. This continuity is provided by interdependencies of new and existing firms within a cluster (Tallman et al, 2004) for example through network interactions (Hendry et al, 2000; Casper, 2007; Schilling and Phelps, 2007; Engel et al, 2011) and the ability to capture knowledge spillovers (Keeble and Wilkinson, 1999; Iammarino and McCann, 2006). In the long run, however, cluster identity may change as old firms are replaced by new ones from different, albeit related, technology sectors using new combinations and reuse of cluster resources and legacies. Indeed, a key characteristic of strong clusters is resilience or adaptability. Martin and Sunley (2011) proposed a four-phase *adaptive cycle model* for complex clusters including (i) reorganisation (or restructuring), (ii) exploitation, (iii) conservation and (iv) release (or decline) stages. The model asserts that resilience and adaptability are high in the conservation and exploitation phases and low in the release and reorganisation phases. Thus we would expect strong clusters to remain resilient and focused (conservation and exploitation) during a period of high industry growth and less so in times of decline. Martin and Sunley suggest that the conceptual and empirical exploration of the applicability of the adaptive cycle model should feature strongly on the research agenda for understanding cluster evolution.

Relating this model to the availability of external finance, key features of the sustainability of cluster growth are the profitability of its leading entrepreneurial firms which have attracted external investment, hence their propensity to go to initial public offering (IPO) or attract buyers. In many ways IPO firms are a microcosm of the cluster they belong to and an important indicator of cluster entrepreneurial health. In the long run, IPO firms give technology clusters legitimacy as without them clusters risk losing entrepreneurs and local private venture capital investors, both essential for the entrepreneurial environment and cluster survival. Thus, we argue that IPO firms within a technology cluster are a good proxy for highly successful cluster entrepreneurial output. IPOs are rare events which can create a huge amount of wealth and fame for entrepreneurs and prestige for the cluster from which they originate.

The geography of venture capital and its impact on regional development is well documented (Florida and Kenney, 1988, Martin et al, 2002; Fohlin, 2008; Zhang, 2011). Venture capital firms (VCs) often cluster in areas with high concentrations of technology-intensive enterprises. The venture capital industry displays a high level of agglomeration due to the information intensive nature of the investment process and the importance of venture capital networks in locating investments, mobilizing resources, and establishing business start-ups. The close proximity provided by spatial clusters is valued by venture capital firms as this allows them to better monitor and mentor entrepreneurial firms and reduces the risks associated with innovation activities (Feldman and Florida, 1994). The existence of well developed venture capital networks in technology-based clusters was found to significantly accelerate the pace of technological innovation and economic development in those regions.

The main goal of this article, therefore, is to ascertain whether clustered IPO firms better adapt to the changing technology environment over time and outperform unclustered IPO firms in the areas of innovation and venture capital investment performance. If they do, then this would help explain cluster sustainability. We investigate the conditions under which technology IPO clusters are complex adaptive systems and to do so we use Martin and Sunley's (2011) adaptive cycle model to explore long term cluster evolution across technology sectors. In particular, we seek to identify and discuss phases of cluster exploitation/conservation and decline/restructuring in relation to clustering and IPO firms. We test hypotheses whether clustered IPO firms are (i) more innovative, (ii) attract more VC investors, (iii) associated with superior investment performance and (iv) adapt better to new industries than unclustered IPO firms whilst IPO firms based in strong clusters(v) outperform those based in emerging or weaker clusters.

Methodology

We examine the evolution of successful ventures within each cluster (from inception to IPO) and contrast aggregate cluster performance over time. The empirical study is based on matched data compiled from the VentureXpert™ venture database and, Delphion™ and NBER/USPTO patent databases. The resulting unique and proprietary dataset consists of 966 U.S. technology firms from 7 sectors and 16 Metropolitan Statistical Areas (MSAs) that received venture capital financing prior to exiting via an IPO in the 20 years from 1980 to 2000. The longitudinal input-output analysis of clustered technology IPO firms allows the various relationships within the adaptive economic cluster system to be modelled as a whole (i.e. patented innovation, venture capital investment performance). By aggregating US

technology IPO firm data at cluster-level, over a period of 20 years from 1980 to 2000, we can evaluate cluster long-term innovation and economic performance and draw meaningful inferences about cluster evolution across horizontal and vertical directions. Clusters and decades are the units of analysis, the 1980s and 1990s, in particular, being regarded as periods of considerable innovation with the emergence of personal computers, software, and biotechnology, etc.

Results

We find that three quarters of all technology IPOs in the period from 1980 to 2000 originated from regional clusters. In contrast with Baptista et al (1998), however, we find no significant difference in innovation performance between clustered and unclustered IPO firms. Clustered IPO firms appear to have attracted more VC investors and investment over the period. When we take strong clusters out of the equation we do not find that a significant difference in innovation and venture capital investment performance between clustered and unclustered IPO firms. Results show that clusters evolved significantly over the two decades as they sought to adapt to convergence and to changing competitive environments. The 1990s are characterised by more innovation of greater importance, larger venture capital investment and IPO value for firms that developed during that decade. When comparing the 1990s with the 1980s, we also find that all technology clusters featured at least one new sector amongst the top three most important sectors of the decade, suggesting an effective recombination and reuse of resources and capabilities. The only exception perhaps is the San Jose (CA) cluster which featured the same three technology sectors in both decades albeit in different ranking order – a sign of the dominance and resilience of strong clusters. We also find that IPO firms based in strong clusters are consistently more innovative, attract more venture capital investment, develop at a faster pace and fetch higher IPO valuation than other clustered or unclustered IPO firms during both decades of the study.

Conclusions

The four-phase adaptive cycle model provides a useful framework for studying cluster evolution trajectories in related industries over the long term. The maturity and gradual decline of the computer hardware sector provide a good case in point. We find evidence that emerging/weaker clusters readily entered the ‘release’ phase of the declining hardware sector to favour the ‘exploitation’ of the promising high growth software sector while dominant clusters in the hardware sector tended to linger in the conservation phase, seeking to milk the sector at the risk of losing market share in the new emerging software industry. As predicted

by the adaptive cycle model, we find evidence of alternative evolutionary trajectories following the release phase: (i) *cluster reorientation* as new related software clusters emerged and swiftly replaced the old hardware clusters throughout the 1990s (e.g. Boston, Los Angeles), (ii) *cluster stabilization* as more resilient clusters underwent a phase of conservation (e.g. San Jose, San Francisco) but no *cluster failure or disappearance* as the period witnessed significant growth in all IPO clusters. The adaptive cycle model, however, failed to explain how another strong and resilient cluster (e.g. San Francisco, situated within proximity of San Jose) adopting a similar conservation strategy in a declining industry sector achieved a different outcome in a related growing sector. Although Martin and Sunley (2011) clearly stated that cluster evolution can be viewed as an adaptive process with different possible outcomes based on interactions of nested systems, they did not provide precise definitions of what these 'interactions' or 'nested systems' are. This lack of definitional refinements and ambiguities pose problems for establishing adequate level(s) of analysis in empirical cluster evolution research. These conceptual issues impose severe limitations in future work aimed at improving our understanding of the heterogeneous evolution of clusters.

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