Building the Human Capital of Knowledge Intensive Firms

The Case of Biotechnology Start-ups

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Abstract: Science-based biotechnology start-ups are part of the new modern knowledge economy. How founders of biotechnology companies organise and build the employment system in their start-up ventures is an area of theoretical and practical concern. While the entrepreneurship literature is growing, questions still remain regarding how founders of start-up firms organise employment of human capital. This paper uses the founder's human and social capital perspective in studying the founder's role in the employment system creation within their new ventures. The links between prior experiences embodying the founders' human and social capital, and the cognitive mental models of founders is proposed. A cognitive approach to studying founder's organisation building activities provides individual level explanations that recognise the effects at the organisational level (Blalock 1984; DiPrete and Forristal 1994). Understanding how the individual's prior experiences interact in different environments may be key to understanding why, when and how different modes of action are used to exploit entrepreneurial processes (Shane 2000). This complex interaction amongst elements of the founders' human and social capital is particularly important in the context of knowledge-based organisations, and their development. This ongoing study reports on a multi-method case study approach examining founders' mental models of the employment system and the organisations that they have built. The preliminary results suggest that founders approach the building of employment systems within their firm with a specific mental model of human capital organisation. These mental models of the employment system emphasise informal and formal managerial and human resource policies and activities that are designed to achieve various aspects of the organisational culture and goals. The findings also suggest that founders' mental models of employment systems are influenced by a variety of human and social capital factors that shape the nature and content of the employment system they form.

Keywords: Biotechnology, Start-Ups, Human Capital, Employment Systems, Mental Models, Bio-Entrepreneurship

Introduction

THE ADVENT OF small entrepreneurial businesses in high-technology sectors contribute to a range of economic effects including job creation, regional development, technology transfer, and technological innovation (Jones-Evans, 1996; Roberts, 1991; Smilor, Gibson, & Kozmetsky, 1989; Stringer, 2000). Biotechnology is of particular interest, as firms have high expectations of growth and development due to economic return from everyday applications (Acharya, 1999; Bud, 1989; Kenney, 1986; Van Vliet, 1998) as well as exponential industry growth as evidenced by the number of biotechnology companies, increased number of approved products from biotechnology processes, market capitalisation and revenues (Kermani & Bonacossa, 2003). The biotechnology industry is one that is knowledge-based and dominated by new small firms that have close ties with university-based scientists (Corolleur, Carrere, & Mangematin, 2004). Knowledge transfer between universities and firms occurs when university-based scientists found a firm with the explicit goal of developing knowledge created in their university lab. In-

deed, the growing interest in knowledge intensive firms has shifted the focus on their management implications (Mehta, 2001; Robertson & O'Malley Hammersley, 2000; Schubert & Ginsburg, 2000; Weigand, DeMoor, & Van Den Heuvel, 2000).

Review of the literature

The majority of biotechnology firms are founded by scientists and this represents a unique population of highly qualified human capital (Bullock & Dibner, 1995). This is an important point as biotechnology organisations are characterised by the value of its founder's human capital and knowledge. One important founder-firm relationship that has received little attention in the literature is the specific organisation building efforts of founders in the employment system of the firm (Murray, 2004). The need for founders and their top management team to recruit and retain a stable and committed workforce in order to deliver the concept's of the founder's business is a crucial issue for new ventures in the establishment phase (Alpander, Carter, & Forsgren, 1990; Boxall & Purcell, 2003; Rubery, 1994). While there have been many studies on the organizing process (Ald-

rich, 1979; Katz & Gartner, 1988; Reynolds & White, 1997; Venkataraman, 1997), relatively few focus on the role of the founder on the employment system of the emergent biotechnology firm (Baron, Burton, & Hannan, 1996, 1999; Baron, Hannan, & Burton, 1999a, 1999b; Burton, 2001).

Bio-entrepreneurs, generally university based research scientists who engage in the commercialization of their research, drive the transformation of scientific knowledge into commercial applications and have been described as a key factor in the development of the biotechnology industry (Audretsch & Stephan, 1996; Etzkowitz, 1998; Powell, Koput, & Smith-Doerr, 1996). In essence, bio-founders are the transition point between existing knowledge of both science and organization and the commercialised science and knowledge-based employment structures of the new entrepreneurial form. While much is known about founders of biotechnology firms or scientific entrepreneurs and their contributions to the new start-up firm (Antonelli, 1999; Murray, 2004; Oliver & Liebeskind, 2003; Oliver & Ramati, 2003; Powell et al., 1996), little is known about their specific organisation building efforts in creating their firms, and specifically how a founder's human and social capital contributes to this process. Understanding this knowledge accumulation and structuring process is of crucial importance (Shane, 2003; Shane & Khurana, 2003; Venkataraman, 1997).

Scientific entrepreneurs are largely seen as scientists who acknowledge the commercial value of their academic scientific research and act in ways to commercialise it (Antonelli, 1999; Oliver & Liebeskind, 2003; Oliver & Ramati, 2003). These include the new set of norms that have been adopted around these entrepreneurial activities among the academic scientific communities (Etzkowitz, 1998; Owen-Smith & Powell, 2001). Despite the paucity of research examining the organisation building activities of these founders, analyses of bio-entrepreneurs and founders of biotechnology firms do exist. The majority of studies on biotechnology or science-based firms have centred on the knowledge capital or social capital of their founders (Murray, 2002; Pisano, Shan, & Teece, 1988; Stuart, Hoang, & Hybels, 1999; Zucker, Darby, & Brewer, 1998), scientific collaborations (Oliver, 2004; Oliver & Liebeskind, 2003), strategic alliances (Calabrese, Baum, & Silverman, 2000; Fiol, 1990), and founders' networks (Jardine, 1999; Kohler, 1976; Lenoir, 1995; Merton, 1957).

The literature of scientist founders' human and social capital offers some insight into the organisation building efforts of the founders. These traditional analyses focus on the scientists' knowledge and human capital, specifically their technical capital that is leveraged in the commercialisation process (Levin

& Stephan, 1991; Stephan, 1996). This process establishes these scientists as the "key" to tacit knowledge generation and transfers, and may form the basis for the biotechnology firm's performance (Zucker et al., 1998). This has led to a greater understanding of the role that academic scientists play in the knowledge generation and appropriation process of commercialisation. However, recent studies have shown the critical importance of relationships, alliances and networks that permeate the workings of the biotechnology firm (Bozeman, Dietz, & Gaughan, 1999; McKelvey, 1996; Powell et al., 1996). The traditional view that scientist founders contribute appropriable human capital requires a view that expands on the various other assets of the founders themselves. Murray (2004), for example, stress that views of academic inventors and their role in the commercialisation need to take into account the prevailing social capital as well as the knowledge contributions of the founders. The bio-entrepreneur thus provides not only human capital contributions such as through the range of scientific knowledge, knowledge of laboratory techniques and expertise, but also social capital such as establishing its network of people for the firm and in the community (Murray, 2004). Bio-entrepreneurs are able to contribute to their firms through the transfer and accumulation of knowledge through their human capital (Agrawal, 2002; Murray, 2004; Zucker et al., 1998), but also through translation of their social capital into networks of knowledge, laboratory affiliation and scientific communities (Murray, 2004). This empirical research stream highlights the role of experience and the accumulation of human and social capital as important in understanding the bio-entrepreneur's role in the commercialisation process.

Within the literature on human capital, several authors have explored the experiences accumulated by entrepreneurs particularly in the decision to become self-employed (Bates, 1990; Davidsson & Honig, 2003; Gimeno, Folta, Cooper, & Woo, 1997; Robinson & Sexton, 1994). Human capital theorists suggest that individuals with broader pools of human capital will be associated with increased levels of productivity (Becker, 1975). This approach to human capital acknowledges the important role of previous experience in forming the basis for entrepreneurial action and behaviour (Becker, 1993; Castanias & Helfat, 2001; Chandler & Hanks, 1998). In contrast to this, the study of social capital has been approached from the perspective of careers (Murray, 2004; Shane & Khurana, 2001). Shane and Khurana (2003) argued that prior career experience mitigates the problems associated with the liability of newness in the process of firm foundings. Experience provides for existing social relationships that make it easier for founders to obtain needed resources, in addition,

it provides firms with organising skills and role familiarity and lastly, experience provides the legitimacy necessary to motivate others to reallocate resources counter to existing norms (Shane & Khurana, 2003). However, while the role of experience and its embodiment in human and social capital is established, the process through which this is entailed is largely unexplored. Thus, we may conceptualise bio-entrepreneurship as the intersection of founder knowledge – direct human capital – and their social capital that will provide indirect human capital assets to the firm.

The implications of this research suggests the need to concentrate on the varying abilities of different

types of entrepreneurs and the important role of their past experiences on their ability to utilise the resources available to them. This suggests the importance for underscoring the previous experiences of founders in understanding their approach to the building of the employment system. Utilising the links between founder's career experiences may highlight the rationales for organisation building. As Shane and Khurana (2003) stated, careers are important not only for their effect on social ties (Granovetter, 1974), but also as a means for learning (Carroll & Mosakowski, 1987). Figure 1 shows the hypothetical relationship between founder experience, resources and start-up resources.

Figure 1: The Relationship between Founder Experience, Resources and Start-up Resources

Evidence of the Impact of Founders

One line of research that may offer an insight into how founder's of new ventures may organise the human capital in their firms is the Stanford Project for Emerging Companies (SPEC) project. The project was a series of studies on young, high-technology firms in California's famed Silicon Valley. This project sought to examine how start-up organisations get established including the process and

mechanisms that explain organisational trajectories and change. In particular, the SPEC studies were designed to examine the founding conditions, the evolution of employment practices, organisational designs, business strategies, and the longer-term consequences of early organisation building (Burton, 2001). Publications from the project have docu-

mented the existence of distinct organisational blueprints or models described as sets of premises governing the employment relation among founders of high-technology start-ups (Burton, 2001). There have been a variety of links found between these organisational blueprints or models, with organisational features such as the evolution of bureaucratisation, administrative intensity, development of the IIR function, and organisational developments such as the replacement of founders with a new chief executive officer, and the chance of going public (Baron & Hannan, 2002; Baron, Hannan, & Burton, 2001; Baron, Hannan, Hsu, & Kocak, 2002; Burton, Sorensen, & Beckman, 2003; Burton, 2001). This stream of research is important because it suggests that the basis for organisation building is rooted in previous cognitive models of employment (Fligstein,

1990; Fligstein & Byrkjeflot, 1996; Guillen, 1994; Hill & Levenhagen, 1995).

The substantiation of bio-entrepreneur's cognitive substantiations represent a "black box" or process mechanism for how experiences may translate into human and social capital. Firstly, cognitive models is built from prior experiences or knowledge that influences actions and information processing (Hill & Levenhagen, 1995; Palich & Bagby, 1995; Shane, 2000). This highlights the origins of human and social capital utilised in the organisation building process. For example, bio-entrepreneurs are thought to be the result of dynamic interactions between universities and research institutions and the supporting role of governments, venture capital and large companies (Muller, Fujiwara, & Herstatt, 2004). This emphasises the role in which their prior university and commercial experiences play in developing model of employment systems (Burton, 2001; Shane & Khurana, 2003). Mental models of employment systems also are guided by prior socialisation in the bio-entrepreneur's training and background (Knorr-Cetina, 1980, 1983; Latour & Woolgar, 1986; Mulkay, 1972). These prior work experiences, as accounted for by a careers perspective, offers bio-entrepreneurs exposure to the employment models available as well as the expectations of work in academic versus commercialised contexts. In addition, they provide bio-entrepreneurs with significant social networks in which to ply and leverage the building of their research and laboratories (Murray, 2004). The specific career experiences helps founders with the organisation building process by offering alternative employment models (Burton, 2001) from which to emulate, or by mitigating the liabilities of newness by influencing the social relationships, management skills and legitimacy of new founders (Shane & Khurana, 2003). Empirical evidence around founder's individual activities supports the role of the bio-entrepreneur's commercial, university, and technical or knowledge capital impact on the building of the organisation (Cooper, 1985; Finkelstein & Hambrick, 1996; Fligstein, 1987). Moreover, firm founding experience may play a part in the conceptualisation of building the human capital of the firm (Burton, 2001; Shane & Khurana, 2003). Founding experience allows bio-entrepreneurs exposure to previous models of employment that worked or failed in their previous firms. This may in fact influence the critical decisions made in building the employment system of the firm (Burton, 2001).

Method

In order to examine the role of these bio-entrepreneurs' experiences in the organisation building process, an in-depth case study approach over three

cases was used to examine the contribution of bio-entrepreneurs' human and social capital in the organisation building process. In particular, this research examines the nature and effects of bio-entrepreneur's human and social capital in the building of the employment system of their firms. This focus is likely to be particularly important for biotechnology companies who are highly dependent on their human resources for their success. Data was collected at two levels in the case organisations using a multi-method approach. First, at the founder level, semi-structured interviews were used to gain an understanding of the organisational building process around the employment system, the pertinent challenges faced by the founder and the origins of the strategy, structure and practices within the organisation. These interviews were used to create "mental models" of factors and causal relationships in the development of the bio-enterprise. Secondly, interviews were conducted at the organisational level. Interviews were conducted with the top management team, line managers and employees within the biotechnology companies. The purpose of the data collection at the organisational level was to gain an insight into the reality of the founder's organisational building process around the employment system. Finally further archival evidence was obtained regarding the founder and their firms including journal articles, business periodicals and company reports. The duration of interviews with employees was typically 45 minutes while interviews with the top management team and founders lasted between 60 to 90 minutes. All interviews were conducted on the employers' premises. In addition, interviews were supplemented with internal company documents and personal observations.

Findings

Preliminary analysis of founder's mental models drawn from the interviews indicates that the founders' mental models of the emergent firm have an enormous influence on the employment systems of their firms. For example, founders in this current research show distinct mental models around the employment system that reflect their ideologies for employment. From the results of this research, mental models are acquired through prior socialisation such as societal, occupational and past work experiences. All founders in this study point to their backgrounds as sources of influence on the mental models of the emergent firm. The preliminary results and analysis also point to the mediating role of key stakeholders such as venture capitalists and lawyers, the organisational strategy of the firm, and the competitive environments of the firms. The choice of employment and other systems develops from the dependence on the environmental resources of the

firms and the labour that is available to it. This is perhaps more urgent in start-up companies than those in the establishment phase. The cognitive substantiation of external environments thus far works in constraining the choice of systems and the practices and policies founders may employ (Boeker, 1989;

Boeker, 1988; Hannan, Burton, & Baron, 1996; Hannan & Carroll, 1992; Hannan & Freeman, 1989). Table 1 provides a comparison of each founders on the basis of their human and social capital endowments.

Table 1: Comparisons of Human and Social Capital Endowments of Founders in all Three Companies.

Human & Social Capital	Company A Founder	Company B Founder	Company C Founder
<i>Technical Expertise</i>	Geneticist	Neonatalogist	Biochemist
<i>Other Knowledge</i>	Commercial contracts	No prior commercial experience	Prior successful start-up
<i>Social Capital</i>	Network of other entrepreneurs	Allied with business partner	Prior enterprise
<i>Career Experience</i>	Science director of other start-up prior	Professor and University administration	Alternate University & industry employment

These knowledge and human capital foundations were combined in unique mental models for each of the companies studied (Table 2). The emphasis on “find the best” in terms of technical expertise is consistent with the ‘star’ models put forward by

Burton (2001) and noted as particularly salient in biology-based enterprises. The results diverge from the SPEC analysis, however, in the differing organizational structures that parallel the social capital and career experiences of the founders.

Table 2: Comparisons of Founder Mental Models

Mental Models	Company A Founder	Company B Founder	Company C Founder
<i>Human Capital Emphasis</i>	Find the best	Find the best	Find the best
<i>Employment Structures</i>	Completely commercial	University affiliated institute, employment is contingent and shared	University-embedded institute with shared employment structures
<i>Institutional Structures</i>	Independent enterprise; IPO	Quasi-independent with University and VC investment	Legally independent, co-located

These findings contribute to understanding the role of biotechnology founders or bio-entrepreneurs in the creation and subsequent building of the biotechnology company. Organizational systems, particularly those related to employment, represented a diversification of founders’ models, labour pool availability, organisational strategy and the competitive environment. The structure and organisation of the employment systems thus were borrowed from other settings privy to the founders and their teams. Utilising a human and social capital approach as evidenced by prior experience allows an understanding of the distinct contributions of founders. As with Burton (Burton, 2001), entrepreneurs do not to become overly concerned with the cultural pressures as represented by theories from the institutional or resource dependency. Rather, the located heterogeneity or homogeneity of employment systems may be due to the founder’s human and social capital as well

as an interpretation of the environment as embodied by the cultural and work experiences of the founders (Saxenian, 2001; Suchman, Steward, & Westfall, 2001). These prior experiences and cognitions work in tandem to produce organisational and industry demands for legitimacy. The role of the founder scientist becomes an important fundamental variable in organisation building.

A final note on the role of the star scientists in the building of the human capital of their firms is warranted. The role of star scientists in commercialising science is of immense importance (Zucker & Darby, 1996). Founders in our firm were influential not only as agents of organisational blueprints but also as disseminators of vision and communication of their firm’s worth (Goldberg & Kirschenbaum, 1988; McMillan & Deeds, 1998). The legacy of founders is therefore profound (Hall & Hofer, 1993; Herron, 1990; Shane & Khurana, 2003; Stuart & Abetti,

1990). Hendry, Arthur and Jones (1995) suggests that what founders do with the employment systems of their firm is of crucial importance as many small business may face many ongoing problems of recruitment and retention due to the inability to compete with other large firms that have formidable advantages. They suggest the use of networking at a strategic time in the industry's development as propitious. This reflects the importance of a founder's social capital in the organisation building process. Boxall and Purcell (2003) also describes the importance of the strategic role of aligning interest among highly talented people and the clever use of "personal

knowledge" to overcome the resource barriers faced by new start-ups. This is essentially the thesis argued by Murray (2002; 2004) in her exploration of human capital and social capital of founders in innovation. This present research provides a mechanism as to how founders of firms are able to solve the knowledge and human capital issues of building a firm including the utilisation of the human and social capital in their firms. The building of the employment system in this current study demonstrates some of the mechanisms through which knowledge transfer is facilitated through these star scientists' models of employment (Corolleur et al., 2004).

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