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The use of Social Networks in
Knowledge-Based Entrepreneurial firms**

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Abstract

This paper combines resource-based and relational perspectives in an attempt to understand the constraints and enablers of Knowledge-based Entrepreneurial firms (KBEs). KBEs denote firms that bring to market new products and services, or which rely on new production processes, based on the deployment and development of new scientific knowledge or high technology. A conceptual model is proposed to explain how the specific requirements associated with these firms influence their economic activity in terms of the ability to identify, act upon, and realize opportunities. Enabling and inhibiting factors are identified, and suggestions for further research are provided.

1. Introduction

Entrepreneurship has received increasing attention from theoreticians and policy makers alike over the past decades as suggested by the abundance of policy initiatives in the area and by the increasing literature on the subject (Acs & Audretsch, 2001). In both arenas, the respective desire to stimulate entrepreneurship as well as to analyze the phenomena is propelled by a recognition of its central role in economic growth. Of special interest is the founding of firms that commercializes new scientific knowledge or high technology, what we can call knowledge-based entrepreneurial firms (KBEs). Despite an increasing focus on KBEs, especially university spin-offs recently, little attention has so far been directed to how KBEs form relations and the impact of such relationships on the growth of the firm. This paper will argue that the growth of KBEs can be analyzed through a more detailed picture of how the networks of individuals and organizations (e.g. firms, universities) influence the way KBEs mobilize resources.

The starting conditions for any given start-up will differ from venture to venture, depending on the context surrounding the event of actually founding the firm. However, common denominators are that the event of starting up is often characterized by an endemic lack of resources (Tether, 2002) and that it is difficult to grow from internal resources only (Liao & Welsch, 2003). Indeed, most have to rely on external sources of resources for their survival. While relations have been demonstrated as important in many industries and among start-ups in general (e.g. Shan et al. 1994), relations may be of particular interest to emergent KBEs. Similarly to Holmén et al. (2004), knowledge-based entrepreneurship here refers to firms dependent upon new scientific or technological knowledge for their core business idea. That is, the term knowledge-based does not refer to the general or even specialized knowledge making up the base of most firms. Rather, KBEs, in our view, denote firms that bring to market new products or services, or which rely on new production processes, based on the deployment or development of new scientific knowledge or high technology.

Given the definition of KBEs it is clear that this type of business venture faces other challenges in accessing external resources as compared to other types of start-ups. On the one hand, they have the same requirements as other entrepreneurial firms in terms of accessing financial capital, facilities, legitimacy and customers. On the other hand, KBEs by definition also carry out, access and interpret research. Such innovative work is often interactive by nature (Van de Ven, 1986), and pursuing R&D internally is moreover very costly in terms of equipment, researchers, etc. This in turn creates demands on the KBE to develop internal capabilities and external relations to 'solve' many of the inherent business problems associated with this kind of venture. Such problem solving activities could, for example, relate to reducing resource requirements, establishing strategic relationships etc. (e.g. Hugo & Garnsey, 2005). Given the importance for KBEs to access external resources it seems that analyzing the growth and management of relations could be particularly helpful to explain also the growth of the KBE itself.

In order to understand how KBEs survive and grow it therefore becomes important to get a more detailed picture of how the networks enabling growth are formed. That is, the networks that are of interest in this article are the networks formed around the focal KBEs, the so called ego-networks (e.g. Borgatti & Foster, 2003). While there is a vast

literature on networks, it does often not provide much detail about the nature of the linkages formed (Rappert et al., 1999) and how it influences the mobilization of resources (Gulati, 1998). Moreover, this literature does often not specifically relate the formation of networks to the requirements of the firm, something that appears important in the case of KBEs. Therefore this article will combine network perspectives with the resource-based view of the firm in order to investigate how and why KBEs can mobilize resources through networks to identify, act upon, and realize opportunities. Focus will moreover be on the emergence phase of a KBE, leaving network growth in subsequent stages aside.

This paper first presents a conceptual model for understanding how and why the KBEs is dependent upon its network. In section 2 then follows a discussion of literature useful to analyze how KBEs may mobilize resources through external relationships to pursue its goals. This background sets the stage for section 3 where more specific questions are treated on how and why the relations, the resource requirements, and the organizational legacy of the KBE may interact and influence firm growth. Based on the framework developed, the final section provides suggestions for founders of these firms as well as for policy-makers and further research.

2. The networks of KBEs

In order to understand the influence of networks on the growth of KBEs, this paper proposes to analyze the interaction between the internal resources and competencies of these firms and the external linkages. Figure 1 presents this paper's view of networks as an essential part in the KBE's growth.

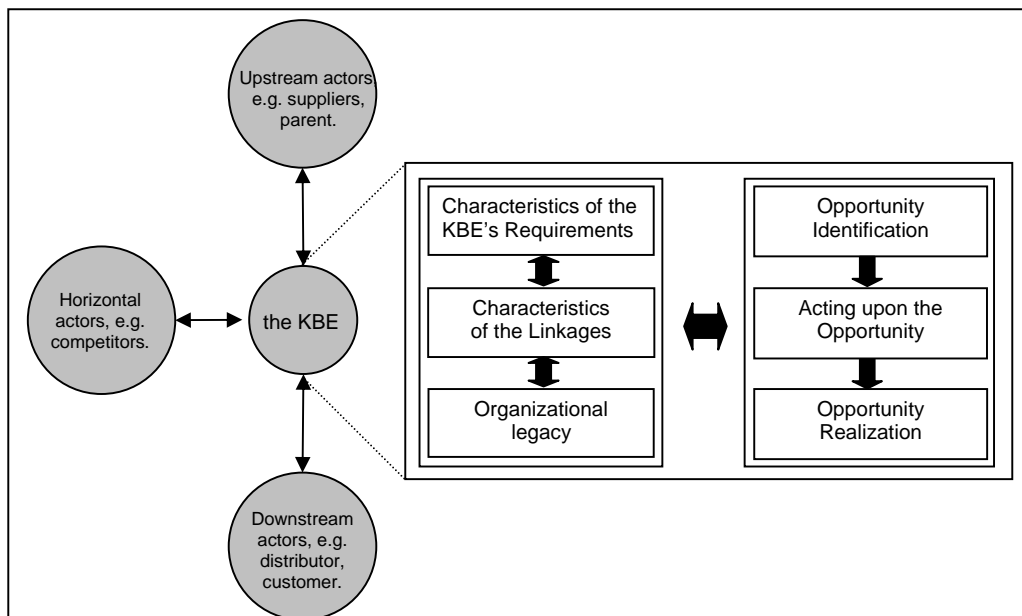


Figure 1: Placing the KBE in terms of internal resources and external linkages

Figure 1 outlines a KBE as situated in a network of existing and to be formed relations with important upstream, downstream and horizontal actors. These relations, it is argued in this article, derive characteristics from the resource requirements of the KBE

and as such also influence the growth of the firm in two important respects. Firstly by way of influencing the identification of opportunities, and secondly by influencing how the opportunities are acted upon and realized. The former issue relates to the focus of the KBE, and the latter to its business model and mobilization of resources. While this in itself adds to an understanding of KBE growth, the differing starting conditions of any given KBE are also a source of influence to the relations used and grown. For a more complete picture then, the organizational legacy of a KBE therefore needs to be included into the analysis. It is argued that in particular the origin and the technology base of the KBE are important determinants to the relations grown and thus also the growth of the KBE. Figure 1 thus visualizes the main topics in this paper.

In order to analyze the relationship between the KBE growth and the mobilization of resources on the one hand, and the growth of relations on the other, this paper basically departs from three perspectives; those of opportunities, the resource-based view of the firm, and social network theory. These perspectives are treated in a general overview below in this section, where they serve to provide a background to the more specific questions treated in section 3.

2.1. The opportunity

The founding and growth of new firms is often anteceded by the identification of an opportunity and an idea about how to expropriate value from it (i.e. a business model). But while the concept of opportunities is important in different lines of literature, there are somewhat different interpretations of it. This section therefore discusses types of opportunities, as well as the concept of business models, in order to find dimensions important for our understanding of why some KBEs achieve growth while others do not.

In evolutionary economics literature the concept of ‘technological opportunities’ has been used to refer to aspects related to industrial sectors or systems. It draws on the fact that sectors differ systematically in their production of innovations, and it is argued that these differences are related to the technology per se (Breschi et al., 2000). That is, it is thought that the appropriability of the technology, the underlying knowledge-base, and the cumulativeness of technical advances, interacts to open up for new opportunities. Given the definition of KBEs, these issues are indeed very important. However, while highlighting the technology, this line of literature directs less attention to market aspects and the perceptions of different actors (Holmén et al., 2004).

In entrepreneurship literature the concept of opportunities has come to occupy central stage in recent years. In this stream of literature there is a strong focus on the demand side of the opportunities, that is, on the identification of a market. There are, however, two somewhat diverging opinions as to how opportunities should be conceptualized. The basic difference between the two perspectives is one of whether opportunities exist and thus are discovered and then exploited by entrepreneurs apt to do so (e.g. Shane, 2000; Eckhardt & Shane, 2003;), or whether opportunities are created and then continuously unfolds over time (e.g. Sarasvathy, 2001; Gartner & Carter, 2003). In the first perspective, the formation of relations has no potential impact on the opportunity as such, but is rather a means for acting upon and realizing it. In the second perspective, though, relations not only becomes a required complement to the internal resource-base, but also a means for continuously adapting and reconstructing the opportunity along the way, or

for expanding the action frame of the venturing process (e.g. Sarasvathy, 2001). In both perspectives, much focus is placed on individuals and their perceptions, although more so in the second perspective since early interactions may radically reshape the opportunity that was originally perceived. Entrepreneurship literature thus adds a market dimension to the concept of opportunities and also recognizes the importance of individual's perceptions of opportunities.

Finally, resource-based theories of the firm use the concept of productive opportunities to explain different ways of utilizing a given set of resources. According to Penrose (1959) limitations to growth not only comes from existing resources, but also from how they are deployed. The perspective thus highlights the limitations in the capacity to perceive and evaluate the potential uses of the resources at hand (Holmén et al., 2004). However, focus is often on excess resources and the opportunities that can be derived from these. In the emergent KBE a more pressing issue is the lack of internal resources and the productive opportunities that can be derived from the firm may thus be more of an issue in the early growth stage of a KBE. Instead, it may rather be other aspects of the resource-based view of the firm related to the resources and capabilities as such that are important to the emergent KBE.

While the identification of an opportunity is important to firm growth, so is finding a way to act upon the opportunity. The way a KBE acts upon an opportunity may be captured by its business model, something which in turn is influenced by the KBEs technology-base. Drawing upon strategy literature, a business model in essence describes "*How the business makes money*" through the translation of technical inputs into economic outputs. This is done by articulating the business along several dimensions; i.e. defining the value proposition, the customer segment, and the value chain of the firm, as well as identifying the cost structure and profit potential, and positioning the firm within the value network (Chesbrough & Rosenbloom, 2002). Although a specification along these dimensions is required for a firm define to its business, the business model is not a fully defined plan of action. Rather, it is a hypothesis that needs to be tested and adapted to new information and possibilities. This suggests that acting upon an opportunity is a process in which a KBE's relations to upstream, downstream as well as horizontal actors play an important role for gathering information that can refine the model. However, while acting upon the opportunity is a process, actions along some dimensions may be restricted by the technology-base of the KBE. The technology per se can, for example, necessitate different strategic considerations depending on whether it is appropriable or not, or whether it overturns or reinforces incumbents' asset values (Gans & Stern, 2003). As a consequence, the technology per se may necessitate some relationships to be formed over others in order to be able to successfully act upon the opportunity.

The different lines of literature thus focus on different, complementary aspects of opportunities. What seems particularly interesting for analyzing the emerging KBE, though, is to combine the aspects that relate to the market with those of how the technology-base per se enables different opportunities. Taking the position that the market opportunity continuously evolves over time, as this paper do, relations become important for the KBE as a means to refine the opportunity and how to act upon it, as well as a means to expand the venturing process.

2.2. The internal resource-base of the firm

Given the definition of KBEs, a KBE's competitive advantage should lie with its ability to develop and deploy science and technology. At the same time, though, such an ability makes demands that may pose problems to the emergent KBE. To understand how, this section provides a more detailed picture of a KBE's resource requirements.

In the 1980s and the 1990s there was a renewed interest in theories taking the resource-base of the firm rather than industry-specific factors as a departure for explaining competitive advantage (e.g. Wernerfelt, 1984; Teece, 1986). According to this view, the initial resource-base of a KBE would be as important as a correct analysis of the industry segment it will enter. This resource-base is often analyzed in terms of resources, capabilities and complementary assets.

Resources often refer to assets in general, (e.g. Grant, 1991; Amit & Schoemaker, 1993), or at times to firm-specific assets, in which case the more commonly available resources are defined as factors of production (Teece et al., 1997). More specifically, resources are commonly defined as stocks of available factors that are owned or controlled by the firm (Amit & Schoemaker, 1993) and include for example financial, physical, human, technological, reputational, and organizational resources (Grant, 1991). These resources can to a varying degree also be made up of both tangible and intangible parts (Dierickx & Cool, 1989). Whether resources denote assets more generally or firm-specific assets in particular, it is the latter that are seen as important for a firm's competitive advantage. These firm-specific assets are often subject to market failure, i.e. are non-appropriable, due to a greater degree of intangibility related to them. Such assets, like knowledge and skills, therefore often need to be accumulated internally in contrast to appropriable assets, such as patents and equipment, which can be traded.

Resources are moreover separated from capabilities. While the distinction is not clear cut, capabilities generally refer to the ability of a firm to coordinate and deploy a resource or a set of resources to achieve a desired end (Amit & Schoemaker, 1993). These capabilities have furthermore no direct market due to their embodiment in the organization (Foss, 1999). It is, for example, difficult to buy a capability such as culture. Instead capabilities need to be accumulated internally. More specifically capabilities include, for example, organizational routines and processes, and core competences (Teece et al., 1997), as well as relational competencies (Lorenzoni & Lipparini, 1999). Together with the firm-specific assets, it is the difficult to imitate capabilities that enable distinctive activities to be performed, activities which in turn are important for generating the firm's competitive advantage.

Another distinct category of resources and capabilities are complementary assets (e.g. Teece, 1986). These can be services such as marketing needed to commercialize an innovation but are more often referred to as parts of a system that a product or innovation needs to fit into if it is not a standalone. For example, software programs need to be compatible with both hardware and operative systems to function and these may thus be regarded as complementary assets. The complementary assets do not need to be acquired, but depending on their nature there may be a need for a KBE to access such assets and capabilities (Gans & Stern, 2003) by forming relations.

For a KBE it is arguably the firm-specific resources and capabilities related to the new scientific knowledge or technology deployed that generates the competitive edge. But these firm-specific assets and capabilities are to some extent also dependent on the more general assets and capabilities for the generation of competitive advantage. For example, valuable as know-how (non-appropriable assets) might be in its own right, its fruitful exploitation is also dependent on access to laboratories, forming patents etc. (appropriable asset). Thus, both appropriable and non-appropriable assets as well as capabilities are important to the new firm. The transfer of these assets and capabilities may to a varying extent occur already at the outset. In some cases, such as spin-off ventures, general assets may be transferred with the establishment of the KBE. Whether or not any appropriable assets have been transferred, there is always a transfer of some firm-specific resources and capabilities as these are more embodied and thus relate more to the founder or the founding team itself. The assets can refer to knowledge and skills as described above, but may also relate to the personal network of the founder/founding team or to information about the opportunity on which the business has started (Shane, 2000). The capabilities transferred with the founder or founding team may in turn relate to, for example, a mind-set of doing business (Chesbrough & Rosenbloom, 2002), or certain embodied organizational routines (Phillips, 2002). Often, however, KBEs like most new business ventures have a shortage of internal resources. To the extent that this relates to appropriable assets, these can either be purchased, provided enough financial resources are at hand, or accessed through relations to external sources. Non-appropriable assets and capabilities on the other hand are inherently more difficult to obtain given their embodied nature. Such assets and capabilities instead need to be accumulated internally which typically is a time consuming process (Dierickx & Cole, 1989), or they may be accessed by developing close relations with external organizations. Furthermore, relations with external organizations may be a necessity also for the purpose of accessing complementary assets and capabilities important to the KBE.

For a KBE then, forming relations may be one necessary activity to solve some the inherent problems associated with this type of venturing. Depending on the requirements, though, different demands will be put on the relations needed for the transfer.

2.3. The external resources of the firm

This section deals with the acquisition of resources and capabilities from outside the boundaries of the firm. In contrast to a traditional dichotomous view of market or hierarchy, it has been argued that such acquisition instead can be seen from a relational, or network, point of view (Powell, 1990; Granovetter, 1985). This may be especially fruitful in the context of new business ventures as the lack of resources, the uncertainty and lack of status often associated with these ventures (Stinchcombe, 1965), make both market and hierarchy difficult choices.

In 1969, Clyde Mitchell defined a social network as “*a specific set of linkages among a defined set of actors, with the additional property that the characteristics of these linkages as a whole may be used to interpret the social behavior of the actors involved*” (1969:2). In the same way, economic sociologists argue that linkages may be used to analytically interpret the social and economic behavior or action of a firm (e.g. Granovetter, 1985). For this purpose linkages and networks are characterized along

different dimensions that can be used to analyze behavior. With regard to gaining access to external resources, a pressing issue for an emergent KBE, two such features may be distinguished; the formality and the strength of a relation. The reason is that different resource requirements may require relations of different strength and formality, and that these characteristics in turn may feed back and influence the behavior of the KBE.

The formality of a linkage refers to the form of exchange taking place. Similarly to the linkages of more traditional economic theory, formal linkages does often not entail much more than the goods exchanged but focus on narrow economic matters like in a one time purchase (Uzzi, 1997; Hite & Hesterly, 2001). Apart from this, formal linkages also refer to relations that are institutionalized in some way, for example, through contractual agreements concerning investments, licensing or access to facilities (Ndonzau et al., 2002). Informal, or embedded, linkages on the other hand signify that a social exchange takes place in addition to the goods exchanged. They are closely related to personal networks and include, for example, previous working relationships, voluntary connections, and kinship and community ties. While formal relations may provide stability and access to resources as well as legitimacy through contracts, informal relations are regarded as facilitating formal relations because they often include thicker, or more fine-grained, information, reciprocity and trust-building. Informal relations are moreover important in their own right as they are often regarded as cheap (Starr & MacMillan, 1990) and flexible, features that correspond nicely to the contingencies of entrepreneurial activity (Rappert et al., 1999). Start-ups, in addition, often have to rely on such informal linkages initially because resource constraint and the liability of newness make it difficult to establish contractual collaborations (Larson & Starr, 1993)

The second point is a linkage's strength, which refers to the frequency, intensity, and reciprocity of the relation (e.g. Granovetter, 1973). The concept of strong ties thus overlaps with embeddedness, as a social relation is likely to develop in such a tie (Hite & Hesterly, 2001). The characteristics of a strong tie also influences the content transferred as strong ties are thought to promote the building of trust and a mutual language that facilitate the transfer of complex knowledge. This has led to suggestions that technology entrepreneurs may benefit more from strong ties, and sparse, disconnected network (Liao & Welsch, 2003). At the same time, however, strong ties may produce information redundancy. The extent to which this is the case, though, depends on the structure of the larger network in which the connected actors are situated, and it is thus beyond the scope of this article since the focus here is on the ego-network of the KBE. Of greater interest, instead, is the shared norms and mental frameworks that may evolve from the trust and mutual language developed in strong ties. Besides facilitating transfer, such mental frameworks also risk generating cognitive inflexibility. That is, they may hinder the absorption of new information generated externally to the relation (Cohen & Levinthal, 1990) and may thus also influence economic action. Weak ties, on the other hand, are ill-suited for complex knowledge transfer but are less resource-intensive, more flexible and also more beneficial for obtaining diverse information (e.g. Powell & Smith-Doerr, 1994).

To the extent that the requirements of a start-up cannot be met with any one relationship, a network of potentially overlapping relations may evolve over time. These may extend horizontally to competitors, vertical upstream to suppliers, or vertical

downstream to customers (Baum et al., 2000) and make up the KBEs ego-network. Because this article seeks to understand the more qualitative aspects of the network that a KBE forms around itself and its effects on growth, less attention is paid to the larger networks where the KBE is but one of many nodes. What is important here with respect to these larger networks, is rather the benefits that these networks can provide the KBE with through membership and association with important actors. Such issues, though, will be returned to in section 3.

Thus, the relations a startup needs to form depend on its requirements. For a KBE, deploying and developing science and technology, one probable requirement is R&D and the KBE thus likely needs to try form technology and innovation networks with different actors in the value-chain. However, R&D is complex in nature and the linkages required to accommodate for its transfer are therefore likely to be close with social exchange entailed in order for the KBE to assimilate the more fine-grained knowledge. Network theory then suggests that such and other relations are likely to influence the economic actions of firms and hence their growth. The remainder of this paper seeks to investigate more closely how and why this is manifested in the case of KBEs.

3. Understanding networks in KBEs

The purpose of this section is to provide a more detailed understanding of how and why a KBE's mobilization of resources to identify, act upon, and realize opportunities in order to grow. In order to help provide such an understanding, it seems particularly interesting to analyze the roles of relations and the organizational legacy as these two features influence the behavior of a KBE and provide access to external resources.

3.1. Identifying an opportunity

A prerequisite for a KBE to grow is to identify an opportunity upon which it can base or expand its business. For an emerging KBE, it may be particularly important to combine the technological opportunity with a market opportunity. This is in turn a process in which relations may influence the outcome.

Given the definition of KBEs one might presume that the technological opportunity often constitutes the starting point of the business. In order to derive the technological opportunity, and to the extent that the KBE seeks more such opportunities, relations with upstream actors, such as researchers and patent attorneys, are likely beneficial because of the limited capacity of the KBE to take on this task itself. Once derived, however, the technological opportunity does not automatically give rise to a market opportunity. In order to derive economic value, the technological opportunity rather has to be matched against the market. That is, problems must be identified to which the technological opportunity can provide a solution. Given the position taken in this paper, this is a process in which the market opportunity continuously evolves through interaction with the environment. In this interaction, relations play an important role because the relations formed confer information; and information can confer benefits if it is new. In the initial stages, it can therefore be beneficial with a vast network of connections with downstream actors in order to gather information about potential market opportunities. This is something that could pose a problem to some KBEs, such as university spin-offs, depending on whether or not their traditional networks predominantly are with upstream

actors like, for example, former research colleagues etc. Depending on the structural properties of the larger network, a smaller set of ties to well positioned actors could also provide much information needed. However, with a smaller set of ties there is also the risk of becoming over-embedded in these ties (Uzzi, 1997), a risk that will be returned to when discussing the realization of the opportunity.

Thus, for an emergent KBE it is important to gather diverse information from both upstream and downstream actors in order to be able to match the technological opportunity with a market opportunity.

3.2. Acting upon the opportunity

To be able to grow, the KBE not only needs to identify an opportunity, but also to find a way to act upon it so as to extract value. To find a way to act upon the opportunity, though, may be influenced both by the KBE's relations and its organizational legacy.

It is argued in this article that the way the opportunity is acted upon to extract economic value may be captured by the business model. Similarly to opportunity identification, constructing a business model is a process in which relations may play an important role. The reason is that relations can confer information that might be well needed to, for example, better segment customers etc. Conversely, relations may also lock the KBE in erroneous ideas about how to act along the different dimensions of the business model. This risk has been empirically observed by Chesbrough & Rosenbloom (2002) in the context of corporate spin-offs where otherwise difficult to obtain relations were inherited from the outset. The firms studied were spun off and sponsored from the Xerox Corporation. As a consequence of retaining strong ties with Xerox, the spin-offs typically came to be strongly influenced by the business mindset of their parent. This in turn came to hamper initial growth as it led the firms astray in the process of finding a customer segment, the value proposition and cost structure etc. that corresponded to their technological opportunity and the size of their business. In a similar manner, Bower (2003) observed how university spin-offs in the biotech sector were strongly influenced by their inherited relations with the universities at the expense of more opportunity-oriented relations that could have aided in the commercialization process.

The organizational legacy can also influence how the KBE should act along different dimensions in order to extract value from the opportunity. The reason is that the technology-base per se, and the technological opportunity derived from it, may impose restrictions on the actions that can be taken. This by way of, for example, the appropriability of the technology, its effects on incumbents firm technology-base (Gans & Stern, 2003), and the complementary assets required for its successful commercialization. A need for complementary assets can require the KBE to form relations with actors supplying these assets, whereas a strong patent on a technology that reinforces incumbent firms' asset values can be used to attract collaborative partners. For a KBE, this may be of special importance because of its base in science and technology. In the biotech industry, for example, huge investments are often required to build the complementary assets required to compete on par with the incumbent firms. Collaboration with incumbent firms is therefore a favorable option for many start-ups and the presence of a strong appropriability regime is likely an enabling factor.

Thus, while relations with upstream actors are important for a KBE for, for example, the supply of R&D, the very same relations could constrain the growth of the KBE by influencing its behavior. In so far as such relations are an obstacle to find, for example, a good value proposition, it may thus be important to be able to cut such ties or at least to establish some distance to that actor. Moreover, the organizational legacy points to the importance of taking factors such as the technology per se into account when considering how to act upon an opportunity. This could furthermore be a plausible part of an explanation for industry differences in ways of extracting value from opportunities, and thus also for differences in growth of KBEs.

3.3. Realizing an opportunity

One of the major reasons for KBEs to mobilize resources through networks is arguably to access external resources in order to realize the opportunity, given that growth only from internal resources is difficult for most start-ups (e.g. Lechner & Dowling, 2003). The ability to access external resources is consequently essential to growth. This ability is in turn contingent on the KBEs skill to form relations, its organizational legacy, and the requirements of the KBE. The skill to form relations relates to a firm's accumulated relational capabilities and is a necessity that the KBE shares with other start-ups why it will not be discussed here. Of more specific interest to KBEs is instead how the resource requirements and the organizational legacy might affect the formation of relations.

The nature of a KBE's requirements can influence the possibilities of the KBE to realize its opportunity in at least two ways: firstly by way of their availability, and secondly by way of the relational investments needed to accommodate for their transfer. While general assets such as standardized components are often widely distributed and thus more easily accessed, special requirements are by definition sparsely distributed and difficult to obtain. For an emergent KBE with a competitive edge in developing and deploying research, R&D is likely to make up an important part of the requirements. Such R&D requirements are often scarcely distributed and may thus be challenging for a KBE to obtain. Unless the KBE is hyped, the obtainment of desired relations, whether these are toward upstream or downstream actors, can be further complicated by the inherent uncertainty often associated with a new firm. The reason is that the unproven status of new business ventures often turn them into risky and non-attractive collaborative partners for established actors (e.g. Stinchcombe, 1965; Hite & Hesterly, 2001).

As a result, the set of initial relations used and formed by new business ventures is often informal and consists of the personal networks of the founders, for example, with former colleagues etc. (Larson & Starr, 1993). This is also suggested by empirical studies that have observed an extensive use of the personal networks of founders in the early stages of new venture generation processes (Bhidé, 2000). Moreover, because of the uncertain status of an emergent KBE, the relations that do form become all the more important in that they signal status as well as convey identity to other actors in the market (Benjamin & Podolny, 1999). As such, affiliations with well-known organizations or individuals increase the status of KBE, which in turn could increase the perceived legitimacy of its activities and provide membership to a larger community, and thus increase its chances of survival and growth. This function of relations could be even more

important in uncertain scientific and technological areas. It has, for example, been suggested that inventions in uncertain technological areas are greatly benefited by the previous adoption by high-status organizations (Podolny & Stuart, 1995). Similarly, Latour (1987) has argued for the importance for scientists to, particularly in uncertain research areas, affiliate their research with that of prestigious others. For KBEs that develop and deploy new scientific and technological knowledge, such relations would thus be particularly enabling as they provide legitimacy, open access to other resources, and create options for future collaborations (Lechner & Dowling, 2003).

While accessing resources are important for a KBE, the number of relations that can be formed with external resources are also important. The extent to which the KBE can mobilize resource through networks is in part contingent on the strength and formality of the relations it does form. The more complex or non-appropriable the assets needed, the stronger the ties needed to accommodate for their transfer. KBEs with R&D requirements are therefore also likely to be involved in closer co-operations. But closer cooperation, or stronger ties, by themselves require resources (Eisenhardt & Schoonhoven, 1996) why it can be difficult for a new KBE with resource constraints to engage in and maintain several such relations simultaneously. While this could suggest forming only a few such ties, there are also risks with too few ties. For one, the KBE may become too reliant on only one, or a small set of relations that may be difficult to substitute. To build a strong tie is a time-consuming process and the social exchange and trust that develop can further make it difficult to switch these ties even in face of contingencies that may necessitate such a shift. It was, for example, observed in Johansson et al. (2005) that university spin-offs could become too reliant on only one set of supply relations that were difficult to substitute. This in turn made them very vulnerable to this partner's ability and willingness to continue collaborate for R&D. Moreover, with too few ties there is also the risk of becoming over-embedded in these ties. That is, strong shared of reference may develop that could blindfold the KBE to new information from downstream or upstream actors important for identifying, or acting upon the opportunity.

To realize an opportunity is to some extent also dependent on the KBE's organizational legacy. Whereas forming formal collaborations tends to be difficult for an emerging KBE because of its unproven status, a KBE may nonetheless inherit some relations from the outset depending on its origin. A KBE may, for example, be deliberately spun-off from a university or a corporation and maintain relations in the form of equity stakes or collaborative research agreements. In the case of university spin-offs it has, for example, been shown that founders often retain a position in academia and that a preferred form of collaboration, which provides the KBE with relatively inexpensive research, is joint supervision of doctoral students (Johansson et al., 2005). It has moreover been demonstrated that researchers' pattern of strong and weak ties are historically determined to some extent (Meyer-Krahmer & Schmoch, 1998), which further suggests continued contacts in the case of university spin-offs at least. But while such inherited relations could greatly aid the emergent KBE, it is important to remember that the same relations could also constrain its growth by influencing the perceptions of how to act upon the opportunity, as discussed above.

Its base in new science or technology, and the complex resource requirements that may follow from this, and the limited number of relations that can be engaged in may

thus render it difficult for the KBE to realize the opportunity. Special requirements are scarcely distributed, and the uncertainty often associated with a new firm can further complicate access to resources. As a result, the KBE is likely to have to rely on founders' personal networks initially, possible inherited relations, or its skills in forming relations.

3.4. Summarizing the role of networks in KBEs

In summary, the competitive edge of a KBE should by definition lie with the deployment and development of new scientific or technological knowledge. This implies difficulties in growing, and, indeed, surviving from internal resources only, why forming relations becomes an important part of the growth of a KBE. The literature review therefore sought to understand how and why resources are mobilized through networks to identify, act upon, and realize opportunities. It is argued that this may be done by combining literature on opportunities, networks, and resource-based theory of the firm, since the opportunity perceived, the relations formed, and the resource requirements are in part dependent on each other. This mutual dependence affect the KBE, firstly, in terms of availability and accessibility of the resources required, and, secondly, in terms of the number of relations it can form. However, the relations that do form also affect the KBE's growth by, for example, influencing the perception of its business. Finally, the requirements of the KBE are not sole determinants of the relations formed, rather, there may be a number of reasons for the evolving network. In relation more specifically to KBEs, it is argued that the organizational legacy, such as the origin of the firm and the underlying technology-base, is important to the relations grown and thus to the growth of the KBE. The influence of the relations and the organizational legacy of a KBE on its mobilization of resources are summarized in Table 1 below.

Table 1: Summary of the influence of relations and organizational legacy on the mobilization of resources to identify, act upon, and realize an opportunity.

	Identification	Action	Realization
Enabling factors	While upstream ties can help identify a tech opportunity, downstream ties are required to match this with a market opportunity. Many weak ties are thus beneficial to obtain diverse information	Many weak ties can provide info that helps find a way to act upon the opportunity. The tech. per se can further enable certain actions, e.g. through its appropriability.	Strong ties may be required to transfer complex assets such as R&D. Personal networks, especially to status actors, or ties to a parent, can facilitate access to these resources.
Inhibiting factors	Strong ties can influence the KBE's perceptions and thus shelter or blindfold it to relevant info about new opportunities.	Strong ties, e.g. to a parent, can influence how the KBE decides to act. The tech per se may also restrict actions.	Complex assets are not commonly available, and it may be difficult for a KBE to access them because of its smallness, lack of status etc.

4. Conclusions and implications

The conclusions and implications that may be drawn from the theoretical framework concerns problems to growth that may be traced to the formation of relations and the organizational legacy as described above. For KBEs these concluding implications are centered on the issues of accessing resources, and the influence that relations convey.

Assuming that parts of the base-line requirements relate to R&D, given the definition of KBEs, the requirements as such can complicate a KBE's possibilities to attract resources. This firstly because complex requirements such as R&D are likely to be scarcely distributed and thus difficult to access, and secondly because the very newness and complexity that form the base of the KBE increase the uncertainty of the venture. The latter can in turn make it difficult to persuade both suppliers and customers to invest in the KBE's products or services since firms are generally not willing to pay for the risks unless there are considerable potential gains to be made. Both problems imply that it becomes all the more important for the founders of KBEs to make use of their personal networks. This in order to access resources as well as to try to associate the KBE with well-known firms or individuals that can increase the legitimacy of the firm and thus reduce uncertainty in the eyes of both customers and suppliers. The importance of this has also been observed empirically in start-ups where an intense period of networking has preceded the buildup of acceptance for new technologies to be able to attract customers at all (e.g. Johansson et al. 2005).

At the same time as the relations that do form can provide the KBE with resources, they may also influence the KBE's perceptions of the opportunity and how to pursue it. The close co-operation likely required for the accommodation of, for example, R&D can over-embed the KBE in the relation, sheltering or blindfolding it to new information from other upstream, horizontal or downstream actors. Two implications follow from this:

Firstly, while the upstream ties are important for the supply of, for example, R&D and information about technological opportunities, it is important that these relations do not come to define the business. Rather it is the customers and what customers value that ought to define the business. It is thus important for a KBE to not only keep a balance between exploration and exploitation on the supply side, but to also cultivate and explore a set of ties with downstream actors from start. This not least because new firms seldom start out with more than a hypothesis of how to act upon their opportunity, granted they start out with a correct perception of the opportunity at all.

Secondly, it is important not only to form ties but also to be able to cut them. Relations may not only blindfold the KBE to new information, but the social exchange developed in strong ties can also come to supersede economic imperatives. As seen in the case of the Xerox spin-off companies, a KBE may thus at times be better off at a farther distance from its collaborative partner. However, in distancing itself from one actor, the KBE may also run the risk of distancing itself from the larger community of which that actor is a part. In order to facilitate such a shift and not become too reliant on only one actor, it is thus important to try cultivating a set of strong supply ties even though this might require much time and resources.

Finally, it is also important to keep in mind that the growth of the KBE is influenced by its organizational legacy. Depending on the origin, the appropriability of the technology, the need for complementary assets etc., different strategic choices has to be made, each which affects the network formed by the KBE to mobilize resources. For any given KBE it thus becomes important to assess the restrictions and opportunities imposed on it by its specific technology-base and context.

Translating these conclusions and implications for KBEs to policy implications it is possible to highlight at least two issues:

The first issue concerns the commonalities and differences related to the problem of mobilizing resources to identify, act upon, and realize opportunities. Given the definition of KBEs, one might assume an importance to access basic research whatever the sector, although the reasons thereof may differ. However, while basic research likely presents a common need and problem to these firms, it seems to run counter to current policy trends advocating that universities do more applied research and commercialization. Thus, the promoting of such a direction, should perhaps be accompanied by a greater extent of attention paid to support and promotion of the mechanisms that facilitate access to research on behalf of these emergent KBEs. Commonalities notwithstanding, though, the differences between sectors may be even greater as technologies per se opens up for action along some dimensions and restrict it along other. This highlights the heterogeneity that exists, not only between entrepreneurial firms in general, but also between KBEs. Similarly, it also highlights a need for heterogeneous policy measures that take these sector differences into account. For example, while it has been argued for the importance to gather diverse information about market opportunities, the ability to do so may differ depending on whether the technology have a roughly defined market beforehand, or not. In the former case, founders may find such information relatively easy even though they from start may be biased to upstream relations, assuming that a significant portion of founders are researchers. In the latter case, though, one might expect a need for public support in the form of, for example, joint, multi-disciplinary EU-projects to increase the chances for any one industry to find a problem to which the technological opportunity can be a solution.

A second policy implication can be derived from the influence relations have on behavior. Since relations not only influence the perceptions and actions of individual firms, but also those of communities at large it may be insufficient to provide help to single KBEs. Instead, efforts may at times rather need to be directed at the networks of firms and individuals that constitute these communities in order to create acceptance or change a prevailing behavior. This is especially important when KBEs innovate into new technological areas, particularly when the technology overturns rather than reinforces incumbent firms' asset values. In such cases, policy measures such as public procurement, legislative changes, public support etc. could create legitimacy for KBEs in the area, and provide incentives for the larger communities to engage in the technology. While it is difficult to provide any general advice since these likely would differ from industry to industry, there are illustrative examples of how policy measures can both support and constrain development. One such example is the development of renewable energy technology in Germany, Sweden, and Netherlands, where legislative changes in Germany motivated the diffusion of the technology (Jacobsson & Bergek, 2004).

To conclude, some limitations to this study should be pointed out. For one, it has only been concerned with the emergence phase of a KBE and not with its subsequent growth stages. This article has consequently only to a limited extent dealt with network growth over time, and has neglected the effects that, for example, a growing KBE's changing resource-base have on its network constellation. Moreover, although some weight has been given to the founders of KBEs, this is from the perspective of their roles in these

firms, not as individuals. Consequently, little attention has been paid to how, for example, individuals could be stimulated and supported to found these firms, albeit some of the findings may be applicable to this end as well. Finally, the findings of this article may not hold equally to all industries, even if knowledge-based. The arguments presented above are largely based on that strong ties are likely needed in the supply relations. This presupposes to some extent a degree of intangibility of the new science or technology developed, an intangibility that makes it difficult access, assimilate, or apply to a market. Different technological fields, though, differ in this respect. Even a given scientific or technological field may differ in this respect depending on the maturity of different sub-technologies (Valentin et al., 2004). Thus, the arguments and findings of this article may be more applicable to fields with higher degrees of intangibility and immaturity.

In summary, the growth of KBEs is a product of an evolution of ties between the founders and employees of the firm and external actors. The theoretical framework above shows inhibiting as well as enabling factors to this evolution of relations relate to the characteristics of KBEs' requirements. Given these factors, it may be important for policy makers to stimulate interfaces between KBEs and the market, to try stimulate communities rather than single firms, and to take the technology per se into account, especially when KBEs try to innovate into new technological areas.

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