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Institutional entrepreneurship in constructing alternative paths: A comparison of biotech hybrids

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ABSTRACT

This paper investigates how firms adapt their innovation strategies to cope with constraints in national institutional environments. It is a comparative case study of Dutch and British dedicated biotechnology firms focusing on a particular type of strategy, the hybrid model. Patterns of skill accumulation and learning present in the Dutch hybrids are indications of how they use institutional advantages to focus on low-risk innovation and build deeper competences while also pursuing high-risk innovation strategies. The Dutch hybrid model offers insight into how firms comply with the dominant logic of the biotechnology field even when their institutional frameworks encourage the pursuit of low-risk innovation strategies.

1. Introduction

Since the birth of the biotechnology in the 1970s, entrepreneurs have been trying to exploit the potential of these promising technologies and investors, universities and governments have supported them in the process. The success of the US biotech industry, and especially the Silicon Valley model (Casper, 2007b) has stood out as an example to other nations and provided a blueprint to jumpstart an industry. Yet the question that continues to be raised is: can economies that have fundamentally different institutional environments orchestrate the Silicon Valley model through policy? What happens to firms and institutions when policy initiatives encourage innovation strategies that are incoherent with their national systems? And what kinds of adjustments do firms make to compensate for the shortcomings in the system?

The central premise of the comparative capitalism stream of literature is that institutional systems influence national economic activity. These systems develop slowly and historically and create different institutional configurations that result in diversity among capitalist economies. Scholars (Amable, 2003; Hall and Soskice, 2001; Tylecote and Visintin, 2008; Whitley, 1999) working in this tradition have identified different ideal types, or typologies, of economic coordination of national economies. A major feature of this work is how it accounts for innovative specialization on a national level, showing how different configurations of institutional systems, such as the financial, corporative governance, labor or public science systems, affect the ways different types of firms create technological advantages in different national contexts.

In the last few years, comparative capitalism, and neo-institutional theory in general, has been criticized for being too deterministic in its view of path dependence (Crouch, 2005) and its lack of recognition of actors' capabilities in changing institutional frameworks or creating alternatives to the dominant paths. The process of institutional change and of the hybridization of institutional systems[1] as actors seek alternatives to dominant paths is gaining more attention from scholars as well as the role of individuals and firms, or institutional entrepreneurship,[2] in the process of institutional change.

One of the concerns that this paper addresses is that prior studies (Casper and Whitley, 2004; Hall and Soskice, 2001) have focused primarily on the national level and neglected to take into account how entrepreneurs at the firm level change institutional configurations, for example by accessing functional equivalents, or substitutes, for financing or skills. A problem that scholars have not yet resolved is the integration of the different levels of analysis

[1] Hybridization of institutional systems implies the combination of institutional systems characterized by liberal market economies or coordinated market economies (Hall and Soskice, 2001). Hybridization of institutional systems is highly debated and some comparative systems scholars believe that hybrid national economies actually constitute different types (Hotho, 2009).

[2] Institutional entrepreneurs are defined as actors, individual or collective, that recombine elements of institutional systems in order to produce change (Crouch, 2005).

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in an effort to explore in much greater depth the various innovation strategies in different sub sectors of 'high technology' industries. For informed policy making, it is necessary to understand the more complex interrelationships between institutional systems and industries at a finer level of analysis than what previous studies have attempted to do.

Studies on the biotechnology industry cross over several areas of interest, including networking, innovation, technology or knowledge transfer, strategic alliances and clustering. In the last decades, our knowledge has increased greatly on inter-firm and university-industry alliances (Arora and Gambardella, 1990; Bozeman and Gaughan, 2007; Gittelman, 2006; Kenney, 1986; Powell et al., 1996, 2005) and the changing institutional environment that created the conditions for dedicated biotechnology firms[3] (DBFs) to flourish (Coriat et al., 2003; Marsili, 2000; Quéré, 2003). From this work, we know that a particular institutional framework, consisting of but not limited to financial systems that provide access to high-risk venture capital, liquidity and shareholder corporate governance and of labor systems that support mobility and flexibility, encourages firms to engage in high-risk innovation strategies (Almeida and Kogut, 1999; Casper, 2007b; Casper and Whitley, 2004; Saxenian, 1994; Tylecote and Visintin, 2008; Whitley, 2007). Questions remain, however, about how DBFs, which are not located in this type of institutional environment, access critical resources to follow high-risk innovation strategies.[4]

This study extends the literature on comparative capitalism by contributing to our knowledge about institutional entrepreneurship on the micro level. The study investigates the affect of national institutions on the development of innovative firms in the biopharmaceutical industry and aims to understand how firms follow innovation strategies incongruent to the national institutional configurations. It challenges the idea that entrepreneurs and firms are bound to follow dominant paths by investigating on a firm level the alternative paths that actors create when faced with national institutional constraints.

In the paper I argue that the British and Dutch DBFs that follow hybrid business models, which combine elements of both high-risk and low-risk innovation, do so for completely different reasons and because of different institutional circumstances. I also argue that the institutional persistence of a high- or low-risk innovation specialization dominate these hybrid DBF strategies. Nonetheless, the findings show that for Dutch DBFs, a hybrid model presents an alternative path for DBF founders to follow more high-risk strategies within institutional contexts that constrain more than facilitate this specialization and makes a case for how Dutch DBF founders engage in institutional entrepreneurship in an attempt to follow the dominant logic of their organizational field.

The paper is structured as follows. First a review of the relevant literature related to the variation of national institutional systems and how different configurations account for radical and incremental innovation on national and sector level is discussed. The research setting and the methodology are presented in the following section. Section four follows with a discussion of the findings from the British and Dutch cases and the paper closes by presenting the theoretical implications and concluding remarks.

2. Variation in economic coordination and innovation strategies

An essential concept put forth in Hall and Soskice's *Varieties of Capitalism* (2001) (henceforth VoC) is that of the theory of *comparative institutional advantage*. Hall and Soskice posit that two ideal types, liberal market economies (LME) and coordinated market economies (CME), are enduring forms of capitalism because each national economy has institutional systems that provide advantages for pursuing specific types of economic activity. The argument is essentially that institutional systems in LMEs support the radical innovation of 'new' industries and that those in CMEs support the incremental innovation of 'old' industries.[5] Furthermore, Hall and Soskice (2001) posit that institutional coherence and complementarities in liberal market or coordinated market economies to the extent that they are 'pure' (or having coherently liberal or coordinated institutional characteristics) will perform better than those economies that do not 'fit' into one of these pure types. Studies (Kenworthy, 2006; Kogut and Ragin, 2006) have challenged this claim and the empirical evidence showed no support for the institutional coherence hypothesis. Kenworthy (2006) used a measurement for institutional coherence developed by Hall and Gingerich (2004) as well as a measurement of his own and correlated institutional coherence with economic performance from 1974 to 2000. In all of his tests the results show a weak correlation between macroeconomic performance and institutionally coherent, pure types of economic coordination. The results leave open to discussion and debate whether mixed forms of economic coordination contribute to better macroeconomic performance, a point that Campbell and Pedersen (2007) makes in his call for researchers to investigate the merits of more hybrid forms of economic coordination.

Hall and Soskice (2001) also posit that institutional systems in LMEs have certain features that are better suited to high-risk radical innovation. Labor markets in LMEs are generally more flexible with low wage bargaining and low employment protection providing high labor market flexibility and mobility. Because high labor mobility reduces the incentives for employees to invest in skills with high firm specificity, employees tend to develop general skills, which can be applied to different firms in the same or different industries. As a result, there is less investment in building firm-specific competences, making it easier for firms to adapt and respond to radical innovations. The capital-based financial systems in LMEs also support easy access to and switching of resources. Stock markets play an important role in allowing firms to access public equity and in allowing investors to exit investments (although there are also trade sale exits) and redirect financial capital into other, newer areas of innovation. These features, typically found in LMEs, allow firms to respond to the inherent uncertainty of high-risk, radical innovation strategies.

The CME argument is the opposing institutional configuration that encourages low-risk incremental innovation. Because labor institutions encourage long-term employment due to high employment protection, employees and firms invest in firm-specific skills and build firm-specific competences that are difficult to change. Firms in this type of labor environment accumulate skills and knowledge and theoretically have institutional comparative advantages in pursuing strategies of incremental innovation. The bank-based financial system prominent in CMEs provides capital for low risk investments, which again is most likely to be invested in incremental innovation.

[3] The definition of dedicated biotechnology firms that is used in this study refers to biotechnology firms that are active in the biopharmaceutical industry and engaged in therapeutic product development and/or technology services based on proprietary technology platforms.

[4] High- or low-risk innovation strategies refer to the level of technological and market uncertainty inherent in those strategies. The level of market uncertainty is external to the firm and possibly shared by a number of firms operating in the same market; technological uncertainty or failure is internal and varies per firm.

[5] Hall and Soskice recognize that there may be other aspects of comparative institutional advantage than only innovation. However, their focus is primarily on innovation since over time it is crucial that firms innovate in order to survive.

The underlying premise of this argument is that institutional systems, the rules of the game, encourage firms to follow strategies that take advantage of their national institutional systems. Therefore, firms in either LMEs or CMEs face isomorphic pressures (DiMaggio and Powell, 1983; Meyer and Rowan, 1977) because their respective institutional systems as a whole offer comparative advantages in either radical or incremental innovation, respectively. The historical nature of institutional systems and the path dependence that they encourage suggest that firms have little choice but to follow the dominant path.

Several scholars (Crouch, 2005; Hage and Meeus, 2006; Morgan et al., 2005; Oliver, 1991; Schneiberg, 2007; Thelen, 2003, 2004) have begun to focus on questions associated with change in institutional systems and the effects on organizational coordination. One important assumption is that institutional change occurs more incrementally given the path dependence inherent in the existing systems. As institutional coherence sustains the use of a set of institutional systems from which benefits are derived, scholars have claimed that changing parts of an institutional system may have adverse affects on the efficiency of the whole system. However, Crouch (2005) and Schneiberg (2007) argue that institutional heterogeneity within institutional systems is necessary for institutional change to take place. Without it institutional entrepreneurs would have no alternative paths to follow and would not be able to provide innovative ways of organizing economic activity. In this perspective, hybridization of institutional systems is the result of recombined elements of liberal and coordinated market economies and provides institutional actors new paths to follow.

Crouch (2005) has criticized the VoC framework as being too deterministic, a criticism that many scholars have applied to institutional theory in general. Crouch's main criticism, however, is the general assumption underlying the two ideal types: that the LME, which is based more on market mechanisms, is the type more likely to survive because investment is focused in newer industries. Crouch continues his criticism of the VoC approach stating that it is a framework that is static, or fixed in time. Logically, since institutional systems are difficult to change and highly path dependent, this static nature means that German firms, and by extension the German national economy, were *always* pursuing incremental innovation and that they were *never* radical. This is simply false as there were periods of time in Germany's economic history when firms were innovating at the forefront of technology, for example, in chemicals or motor vehicles.[6]

The reverse argument can be made for firms operating in LMEs. For radical innovation to take place often years of incremental innovations have preceded it. Yet, the VoC framework offers little room in their model to explain how the ideal types of LMEs and CMEs support varying levels of radical and incremental innovation in industries over time or to account for an organization's capability to engage in both radical and incremental innovation.

Other scholars have also criticized the deterministic nature of the VoC approach. Both Lange (2009) and Herrmann (2008) have studied the pharmaceutical industry in Germany, typically considered to be a CME, and argued that German pharmaceutical firms, including biotechs, follow high-risk, radical innovation strategies. Even though the institutional context in which these firms operate theoretically constrains access to the critical resources needed to engage in high-risk innovation, Lange and Herrmann argue that firms use functional equivalents, or substitute sources, such as in accessing international sources of risk capital or labor. However, this evidence does not mean that firms uniformly have access to functional equivalents. Casper (2009) points out that the studies of Herrmann and Lange focused on the select few that were able to take advantage of international functional equivalents. Yet, it is unknown how much of a lasting effect these alternatives for the select few provide for the majority of the firms facing constraints in the institutional environment. The following section offers a more detailed account of how radical and incremental innovation is associated to liberal and coordinated market economies.

2.1. Challenging the notion of radical and incremental innovation

In the introduction of the *Varieties of Capitalism*, Hall and Soskice (2001) presented empirical data based on patent analysis that showed the industries in which a number of OECD countries were the most innovative. From this data they concluded that the innovative industries in LMEs were those that were related to 'new' industries, such as medical engineering, biotechnology, semiconductors and telecommunications. In the same way, they concluded that the innovative industries in CMEs were related to 'old' industries, such as mechanical engineering, product handling, transport, consumer durables, and machine tools. The 'new' industries were associated with radical innovation and the 'old' industries with incremental innovation.

This is an important association and begs the question why industries are either purely radical or purely incremental. Hall and Soskice provide a brief explanation as to how they define radical and incremental innovation and how they apply it to the industries in their empirical data.

> "... radical innovation ... entails substantial shifts in product lines, the development of entirely new goods or major changes to the production process, and incremental innovation, marked by continuous but small-scale improvements to existing product lines and production processes." (Hall and Soskice, 2001, pp. 38–39)

However, the empirical evidence on national institutional configurations and innovation specializations to date is inconclusive. A study from Taylor (2004) challenged this premise in the VoC framework and found that over time (20 years) the patenting of firms in specific national systems did not follow the patterns that the VoC framework predicted and that the VoC results hinged on a major outlier, the U.S.A. When the U.S.A. was excluded, the VoC framework lost its predictive power and LMEs appeared to be less radically innovative than some CMEs (such as Japan). Yet, Casper and Whitley (2004) by looking at subsectors of the biotechnology and software industries showed that firms specialized in incremental or radical sub-sectors of these industries according to the expectations of specific institutional configurations.

2.2. Regional and sectoral systems of innovation

In recent years not only have scholars of comparative capitalism studied institutional systems with the purpose of connecting them to innovation strategies but also scholars working on national and sectoral systems of innovation (Carlsson, 2006; Lundvall et al., 2002; Malerba, 2002; Nelson, 1993, 2002) have been investigating the topic to understand how institutional systems affect innovation and how innovation may also affect institutional change (Hage, 2006).

One of the most imitated models of an innovation system is that of the Silicon Valley model (Casper, 2007b; Saxenian, 1994), both within the United States and abroad. The Silicon Valley model is the standard for policy makers when they consider orchestrating the institutional systems needed to engage in high-risk innovation. The close proximity of firms to a knowledge base and the availability of venture capital to seed and grow a new venture are intended to entice entrepreneurs to commercialize new scientific knowledge

[6] Germany is used as an example because it is commonly referred to as the quintessential example of CMEs.

or inventions. However, only a few regions have been successful at replicating the model.

Casper's (2007a) recent study on the emergence of the San Diego biotechnology cluster, poses the question why so few biotechnology clusters with radically innovative firms have succeeded in the United States. There are many regions in the United States with world-class universities and medical research. Yet, only the San Francisco, Boston and San Diego regions have been able to create and sustain successful biotechnology clusters. The VoC perspective does not provide an adequate explanation as to why there is regional heterogeneity in the institutional systems of national economies. The explanation that Casper offers lies in the social network within a cluster that creates a 'flexible recycling mechanism' (Bahrami and Evans, 1995) of knowledge and labor. Unsuccessful clusters that remain small and do not generate a critical mass of firms are unable to create this social network that is not only used to share information and ideas but also to lower the risk that employees face in accepting a position in high-risk biotechnology firms that have high failure rates.

Countries outside of the United States, for example Germany, the Netherlands and other continental European countries, have also tried to replicate parts of a Silicon Valley model in an effort to increase high-risk innovation in 'new' industries. From a VoC standpoint, the German biotechnology industry is an intriguing case to study as it represents a stark contrast with the low-risk, incremental innovation in 'old' industries that the German institutional systems support. According to the VoC framework, one would expect that the comparative institutional advantage of Germany's institutional framework would not support the high-risk innovation associated with biotechnology firms and the findings from Casper and Whitley (2004) concur, suggesting that German biotechnology firms follow strategies of low-risk innovation within the biotechnology industry.

2.3. Technological innovation in biotechnology

The extent of the differentiation among technological specializations of biotechnology firms that scholars use differ greatly. Early studies, in the 1990s, focusing primarily on how new biotechnology firms acquired resources (Almeida and Kogut, 1999; Arora and Gambardella, 1990; Baum and Silverman, 2004; Deeds et al., 1997, 2004; Junkunc, 2006) generally studied the biotechnology industry as an aggregated whole and made very little distinction between the types of innovation strategies these firms followed. Other studies (Casper and Karamanos, 2003; Casper and Whitley, 2004; Swann et al., 1998) distinguish between biotechnology firms usually on dichotomous terms, those focusing on therapeutics, which involves high levels of technological uncertainty and can be considered to be high risk, and those focusing on other general purpose technology e.g. diagnostics or platform technologies such as bioinformatics software and gene sequencing equipment, having lower levels of technological uncertainty and therefore lower risk.

In recent work on the biotechnology industry, scholars (Hopkins et al., 2007; Malerba and Orsenigo, 2002; Nightingale and Martin, 2004; Pisano, 2006) have begun to call into question the 'radical' nature of biotechnology and assert that biotechnology is "following a well-established incremental pattern of technological change and 'creative accumulation' that builds upon, rather than disrupts, previous drug development heuristics" (Hopkins et al., 2007, p. 566). In Pisano's book *Science Business* (2006), he argues that the institutions used to commercialize biotechnology inventions[7] have been 'borrowed' from other technological disciplines such as the semiconductors industry, which has a very different nature of technological innovation than biotechnology, and questions whether this 'anatomy' of the industry is sustainable. Pisano points to three aspects that make biotechnology a challenging sector: (i) the uncertainty of the science or technology, (ii) the heterogeneous and complex nature of the science, and (iii) the need for cumulative learning. On the surface, the dominant paradigm of liberal market economies that theoretically encourages high-risk innovation tends to work against cumulative learning and knowledge primarily because of the focus on competence destruction and reconfiguration rather than on competence accumulation.

The definition of radical and incremental innovation, as defined by Hall and Soskice (2001), is ambiguous and does not reflect the breadth of innovation strategies that DBFs follow or the ability of DBFs to combine innovation strategies or change among them. In general, the distinction between radical and incremental innovation in the biotechnology industry has been treated rather lightly in the literature with most studies assuming that the biotechnology industry as whole is radically innovative. In a few studies, radical innovation is associated with drug discovery and incremental innovation with platform technologies (Casper and Whitley, 2004) and then these are tied to the national institutional configurations (LMEs or CMEs) that support either radical or incremental innovation. Yet, in both institutional contexts DBFs follow both high- and low-risk innovation strategies. This leads to the question of how DBFs access requisite financial and labor resources to follow innovation strategies that theoretically are discouraged by national institutional configurations.

Given the heterogeneity of innovation strategies in the biotechnology industry on the firm level, I have chosen to use a distinction between high-risk and low-risk innovation strategies. The link between these strategies and radical or incremental innovation strategies is not directly related. A high-risk innovation strategy has a high level of technological uncertainty and may include innovations of either radical or incremental nature.[8] Low-risk innovation strategies are associated with low technological uncertainty and may not involve innovation at all. If it does, the nature of the innovation strategy will, most likely, be incremental. Presumably, radical innovations stem from technology that is highly novel and uncertain, in other words high risk, and create the disruption to industry patterns and coordination that is associated with radical innovations.

2.4. Institutional configurations of biotechnological innovation

In extending these assumptions to the biotechnology industries in the UK and Netherlands, I assert that the UK has characteristics more typically associated with LMEs and the Netherlands has characteristics more typically associated with CMEs. In comparison to the Netherlands, the UK has a relatively more mature biotechnology industry that began in the 1980s and grew organically in the following decades. Having had a number of successful biotechs in the UK, a network of specialized venture capitalists in biotechnology has developed within the British financial system. The existence of liquid stock exchanges has facilitated the development of the venture capital network as investors have the possibility of floating firms and exiting investments. British biotechs have consistently raised more risk capital than other European countries; in 2010, 60% of the

[7] This term is used here rather loosely and applies to biotechnology innovation for pharmaceutical applications in a very general manner.

[8] New therapeutic or diagnostic products that use novel, often proprietary, technological platforms constitute products involving high risks of technological failure. But new therapeutic products that use proven technology and perhaps compounds in the public domain are also considered to be high-risk even if they are based on incremental innovations. In other words, the technological failure or risk in bringing the latter type of product to market can be equally as high as for the former type.

capital raised by British biotechs was in the form of venture capital (Ernst and Young, 2011). The availability of this risk capital allows British biotechs to pursue technological opportunities and encourages firms to follow high-risk innovation strategies. The corporate governance system associated with the ownership of biotech firms is predominately insider-dominated control (Tylecote and Visintin, 2008) due to private equity ownership but this type of governance holds even for biotechs that are publicly listed for which one would expect more outsider-dominated control. The typically concentrated ownership of publicly listed British biotechs gives major shareholders, usually one or two owners, a large controlling shareholding. Insider-dominated control is conducive to the pursuit of high-risk innovation strategies as owners are highly involved in the strategic decision making and control of the firm, which requires a level of technical understanding and may lead to a higher level of patience from investors.

The low employment protection, or flexible labor markets, in the British labor system supports biotechs following innovation strategies that require high levels of organizational reconfiguration and competence destruction (Howell, 2000; Thelen, 2001). Firms can easily access skilled labor and also easily dismiss redundant labor. The emphasis on a flexible labor market creates incentives for workers to invest in generic skills of low specificity that can be easily transferred to other firms. Secondly, the existence of an active stock exchange allows British biotechs to effectively use financial incentives in the form of stock options to retain employees and reduce appropriability risk associated with employee defection. This configuration of systems is highly supportive of innovation strategies involving high-risk and uncertainty.

On the other hand, it is not to say that British biotechs are not able to follow innovation strategies that rely more on cumulative knowledge. In this type of innovation activity there is an assumption that knowledge and skills have high firm specificity. The low employment protection in the British labor system would provide lower incentives for employees to invest in firm specific knowledge related to proprietary technology. However, it is plausible that firms could offer incentives that encourage the development of this technology- and firm-specific knowledge, for instance the use of share or stock options and bonuses to retain the employee at least until the success or failure of the innovation activity. Moreover, technology-specific skills and knowledge would also have more value on the external labor market than firm-specific skills.

The Dutch biotechnology industry, in contrast to the British industry, is relatively young. The Dutch (pharmaceutical) biotechnology industry has grown largely due to government incentives initiated in the late 1990s. The schemes were successful in increasing the number of Dutch biotech firms; however many of these firms have remained very small and undercapitalized. In 2010, Dutch biotechs had approximately 45 products in various stages of clinical development; the Netherlands ranked 9th out of 15 European countries. The UK ranked 1st with British biotechs having approximately 240 products in development (Ernst and Young, 2011).

The state of the Dutch industry has hampered the development of a specialized venture capital network. Until recently there was only one specialized venture capitalist investing in Dutch biotechs. The existence of a stock exchange has also not benefited Dutch biotechs as only seven Dutch biotechs have gone public in the last 20 years. The Dutch financial system is traditionally more bank-based (Hoogduin and Huisman, 1998; van Iterson and Olie, 1992), with large insurance and pension funds providing most investment capital. The risk orientation of these types of investors is directed towards low risk investments and would limit access to risk capital that Dutch biotechs would need to take advantage of technological opportunities. The corporate governance system, as in the UK, would be more akin to insider-dominated control; however for substantially different reasons. A high level of coordination between stakeholders characterizes economic organization in the Netherlands (Bassanini and Ernst, 2002; Visser and Hemerijck, 1997). For this reason the Netherlands is commonly referred to as a CME and stakeholders (e.g. owners, managers, employees, unions, etc.) have a high level of involvement in the strategic decision making and control of the firm. Control is therefore predominately insider-dominated rather than outsider-dominated and as such, theoretically, conducive to high-risk innovation strategies in that it allows for high visibility and understanding of the technology and resource needs among the stakeholders.

In the Dutch labor system, the limited labor flexibility in the form of (relatively) high employment protection makes resource reconfiguration through external labor flexibility[9] difficult to accomplish. Long-term employment patterns in the Netherlands are persistent due to a number of reasons. First the strict dismissal laws make it difficult for employers to dissolve employment contracts and offer workers a high level of job security (Wilthagen and Tros, 2004). Secondly, the tradition of wage bargaining and use of collective wage agreements reduces the wage differential and the financial incentive for workers to switch employers. Lastly, because employers cannot reconfigure labor resources easily using external labor markets and because workers have fewer financial incentives to switch employers, firms are inclined to invest in the skill development of their employees, thereby potentially increasing firm-specific knowledge and employee lock-in. The Netherlands also lacks a strong tradition in pharmaceuticals and there has been an absence of large-scale reorganizations in pharmaceutical firms. That is not to imply that pharmaceutical firms in the Netherlands have not adapted to changes in the industry but they have possibly accounted for changes (or reconfiguration) by using internal flexibility. The institutional conditions in the Netherlands are conducive to low-risk innovation strategies and would provide advantages to Dutch biotechs following incremental, or competence enhancing, innovation strategies.

Accordingly, I hold the following expectations. I expect British DBFs to follow high-risk innovation strategies because the national financial systems support access to risk capital that is provided primarily by venture capitalists and public equity markets. I would also expect high-risk innovation strategies to be associated with labor systems that support flexibility and mobility because of the technological uncertainty inherent in the strategy. Without a certain level of flexibility in the labor system, DBFs would be reluctant to follow strategies involving high levels of uncertainty because they would be restricted in their actions to compensate for technological or market failure. Therefore, I would expect relatively more British DBFs than Dutch DBFs to follow high-risk innovation strategies that focus on new (therapeutic) product development.

As for low-risk innovation strategies, I would expect the national systems to have much less influence on the innovation strategies of firms. As these DBFs require less risk capital, financial systems that lack (or have less developed) venture capital or public equity markets should have less effect on the DBFs that follow low-risk innovation strategies. However, I expect labor systems to have a substantial level of influence on low-risk innovation strategies. Because DBFs pursuing low-risk innovation strategies presumably have generic technology, they differentiate their products and services with the knowledge and competences of their employees. Labor systems that encourage long-term employment patterns and

[9] Flexibility is used here in regards to external-numerical flexibility (Wilthagen and Tros, 2004), which is the numerical adjustment of external labor market, or more generally the 'hire and fire' flexibility. Other forms of flexibility are internal-numerical, functional and wage flexibility.

that are less mobile should provide advantages for DBFs that follow low-risk innovation strategies. Therefore I would expect relatively more Dutch DBFs than British DBFs to follow low-risk innovation strategies.

3. Methodology

3.1. Research design

This research uses a comparative case study design in order to understand how institutional factors affect the strategies of DBFs. By using multiple cases with embedded units of analysis the case study approach is an appropriate method for the research question as it allows an in-depth rigorous comparison of the two national contexts. The replication logic includes both literal logic, that the cases predict similar results, and theoretical logic, that the cases predict contrasting results but for predictable reasons (Eisenhardt, 1989; Yin, 2003). To guide the sample selection and analysis, ideal types were created that defined particular business models and the expectations of the characteristics of these models. These ideal types serve as a conceptual tool to categorize the organization of DBFs a priori and help to interpret the collected data.

To identify the DBF business models, several secondary data sources of firm listings were used to compile a list of DBFs in both countries. In the Netherlands this was fairly straightforward. The Dutch Ministry of Economic Affairs (Ministerie van Economische Zaken), having initiated a five-year BioPartner program to stimulate the growth of biotechnology industry, published five annual reports on the state of the industry (Life Science Sector Report, Dutch Ministry of Economic Affairs, 2002–2005). This report included a summary of various developments within the sector, such as entries and exits of firms, venture capital funding, mergers and acquisitions, as well as a comprehensive list of Dutch DBFs. In the UK, compiling an initial list of DBFs was more difficult as there is no single listing of biotechnology firms publicly available and several sources had to be used to compile the British DBF list. The main sources include: (i) British BioIndustry Association; (ii) regional biotechnology associations; (iii) company listings from science parks; and (iv) portfolio listings from venture capitalist firms. Only DBFs focused on pharmaceuticals were selected from these associations' listings. The lists were consolidated and duplicates were removed.

To classify the business models, a general distinction between products (e.g. therapeutics, diagnostics) and services was used, as has often been used in prior studies. However, this main category distinction was further refined through an inductive and iterative analytical process as components of the business models became clearer. Product business models were further subdivided into three distinct groups: (i) drug discoverers and developers, (ii) diagnostic products and (iii) equipment or reagent suppliers. Service business models were subdivided into two sub-categories: (i) services based on proprietary technology and (ii) services based on generic technology. Table 1 provides an overview of the characteristics used to classify business models. Furthermore an additional main category of hybrids was identified. The hybrid model contains DBFs that mix models or form combinations of any of the five other models and is the model that is the focus of this paper. The hybrid model combines products and services and was chosen because it incorporates both low and high-risk innovation strategies. In this way, it provides the opportunity to analyze the characteristics of DBFs' strategies and determine whether an innovation specialization predominates. The resulting categorized list of pharmaceutical DBFs consisted of approximately 200 firms in the UK and 70 firms in the Netherlands. Table 2 presents a count of the firms according to business models.

3.2. Sample

This paper focuses on one of these models: hybrids that combine both drug discovery and services. The sampled hybrid DBFs primarily combined a discovery model and a platform technology model; however a few of the DBFs combined the discovery model with services based on generic technology. The sampling strategy can be best described as quota sampling in which a set number of cases (firms) were selected from the sub-group of hybrid firms.

DBFs were selected for in-depth interviews based on business model fit, number of employees (more than 10), age (at least two years old) and type of ownership. The number of cases was determined by saturation, the point at which additional cases revealed relatively few new insights. The sample is not representative of the total population of biotechnology firms and there are a total of eleven hybrid DBFs included in the sample: five British cases and six Dutch cases. Appendix A provides an overview of the general characteristics of the hybrid DBFs included in the sample. The DBFs in the sample were founded between 1992 and 2005; seven of the firms originate from university environments. At the time of data collection in 2006 and 2007, all but two firms had raised funding from either venture capitalists or flotations; seven of the firms were publicly listed. Additionally the appendix provides the job titles of the employees interviewed for the study (Table 3).

3.3. Data collection

In-depth, semi-structured interviews were held with company founders and executive management as well as with institutions. Secondary sources such as industry reports, databases, company web sites, press releases, trade articles, annual reports and company documentation were used to verify the data collected from interviews, determine chronological event histories of the DBFs selected and to build individual career histories of executive management teams.

The interviews were held on-site and focused on gathering information about the founding model and the current model, financing, labor relations, coordination and control, product development and inter-firm relations with collaborators, competitors and suppliers. An emphasis was placed on uncovering the changes that had taken place from the founding to the time of data collection (2006–2007). To gather sufficient detail on the founding and financing history, an original founder of the DBF was interviewed. Often this founder was also a current member of the executive management team, usually the chief scientific officer; however in the few cases in which the founder was no longer employed by the DBF, either the longest tenured employee was interviewed or the original founder was contacted. Since information about the initial founding is often anecdotal, it was crucial to ensure validity by gathering data retrospectively from a person who was personally involved in setting up the firm. In the cases where the founder was no longer involved in the current operational activities of the DBF, an additional interview was held with a current executive level manager, such as the chief executive officer or chief operating officer. Among the 11 hybrid DBFs, 15 interviews of an average duration of 90 min were conducted. Additional interviews were held with venture capitalists and other institutional organizations such as technology transfer offices and policy makers, which were primarily informative in nature and conducted to understand the context of the biotechnology industry in both countries. However, whenever possible and appropriate the interviews were used to validate and triangulate data from the hybrid DBFs. This was particularly the case with interviews held with venture capitalists that had invested in three of the selected DBFs.

Table 1
Key features of the institutional conditions of financial, corporate governance and labor systems.

	UK	NL
Financial and corporate governance systems		
Access to risk capital for technological opportunities	Relatively high due to network of specialized VCs and informal investors	Relatively low due to lack of network of specialized VCs
Access to stock market liquidity for investor exits	Alternative Investment Market (AIM), high liquidity	Alternext, low liquidity
Dominant type of corporate governance	Insider-dominated	Insider-dominated
Owner visibility of technology innovation	High	High
Stakeholder inclusion	High among owners, partners, managers; moderate among highly skilled employees	High for all stakeholders
Labor systems		
Stakeholder inclusion in wage bargaining	Low, due to weak unions and low coverage of collective wage agreements	High, due to strong social partners and high coverage of collective wage agreements
Employment protection, labor legislation	Low; relatively easy to 'hire and fire' resources; relatively high flexibility in external labor market	High; complex dismissal legislation deters employers from terminating employment contracts; relatively low flexibility in external labor market and high flexibility in internal labor market
Skill development and training	Development of general, transferable skills due to low employment protection; low firm specificity and low employee lock-in	Development of firm-specific skills due to high employment protection; high employee lock-in
Ability to reconfigure labor resources	High; flexibility in external labor market facilitates adaptation to competence destruction	Low; flexibility in internal labor market facilitates skill accumulation
Labor mobility	High; low employment protection combined with emphasis on general skills contributes to high labor market mobility	Low; high employment protection encourages long-term career patterns that contribute to specificity of skill development and low labor market mobility

Table 2
Overview of key terms used in classifying DBF business models into the ideal types.

	Product models			Service models	
	Drug discovery and development	Diagnostics	Equipment or reagents supplier	Service–proprietary technology	Service–generic technology
Value creation (mission, vision, purpose)	Discover or develop new treatments, therapies or medicines for specific diseases	Diagnosis of disease Diagnostic tests or tools Diagnostics to detect or identify	Develop instruments, arrays, bio-implants, etc. (equipment) (bio)chemicals, raw materials, cells, etc. (reagents)	Own patented technology enabling drug discovery and development	Contract research, contract manufacturing Services facilitate drug development
Products	Portfolio of products in clinical stages May or may not be based on proprietary technology	Information on products and diseases Information on who benefits from product (patients) Packaged as kits	Description of proprietary technology (equipment) Catalog of products (reagents)	Explanation of technology and the areas of application Benefits of using technology	No physical products Description of expertise or knowledge
Services	None	None	None	Description of services Customization of services	Broad offering of services: clinical management, standard lab experiments, consulting
Markets (customers, collaborators)	Intention to outlicense Information about potential market opportunity (patient population) Collaborators	Information on distributors Online orders Information on who buys product	Outlicensing or sales, distributors (equipment) Online orders, distributors (reagents)	Outlicensing use of technology Customer projects with other DBFs, Pharma's, laboratories	Customer projects with other DBFs, Pharma's, laboratories

Table 3
Count of DBFs per classification.

	Total	Product			Service		Hybrid
		Discovery	Diagnostics	Suppliers	Proprietary technology	Generic technology	
UK	188	64	7	26	42	21	15
%		34.0	3.7	13.8	22.3	11.2	8.0
NL	67	18	6	12	12	12	7
%		26.9	9.0	17.9	17.9	17.9	10.4

Source: Own data compiled from list of DBFs and corporate information.

3.4. Data analysis

All the interviews were digitally recorded, transcribed, and coded using binary or categorical codes. The coding aided the identification of patterns among the variables and these were then compared to determine the degree to which they were consistent with expected explanations and inconsistent with alternative explanations. This follows the pattern matching logic recommended for case studies (Yin, 2003). Reliability was established by using a detailed interview schedule and a case study database. These techniques ensured that the data collection focused on gathering facts.

Having written case summaries of each DBF and coded the transcribed interview data, the process of identifying themes and patterns in the data took place by creating various types of data matrices (Miles and Huberman, 1994) and drawing conclusions from these matrices by contrasting and comparing the data. The approach taken most closely resembles what Langley (1999) refers to as a 'synthetic strategy'. This approach entails taking the data from the summaries and transforming them into 'variables' that synthesize critical components of the events. The constructs (or variables) used to analyze the data are developed through a combination of inductive exploration and coding. This approach enables researchers to also trace causal links and draw richer conclusions based on multiple cases that show how and why the identified variables lead to specific outcomes.

4. Discussion of the findings

The hybrid business model has been used by DBFs in the UK and the Netherlands with varying degrees of success. From evidence in the data set, the use of this model dates back to the early 1990s. This section probes deeper into the reasons why these firms chose hybrid strategies, examines the changes that the DBFs experienced while following this strategy and shows that there is a dominant orientation towards a specific innovation specialization.

4.1. Access to external financial resources

The most cited reason for choosing a hybrid strategy was the immediate financial benefits. Hybrids that combine services and product models generate revenue, perhaps a modest revenue stream, but generally enough revenue to sustain the service operations of the hybrid DBF. Founders following hybrid strategies realized, however, that retained earnings from their revenue would not cover the costs associated with developing drug products and needed to search for external financing.

There are very distinct patterns of external financing between the British and Dutch DBFs (Table 4). Three of the British hybrids raised their first round of external financing[10] through the public equity markets, essentially bypassing venture capital investment.

Table 4
Type of external early stage financing, additional to internal sources (count of DBFs).

	Total $n=11$	UK $n=5$	NL $n=6$
Specialized VC	4	0	4
Corporate venture capital	1	0	1
General VC	2	1	1
Charity/trust funds	0	0	0
IPO	4	4	0

Source: Own data from interviews and from corporate web sites.

Table 5
Time to first round of external early stage financing[a] (count of DBFs).

	Total $n=11$	UK $n=5$	NL $n=6$
≤2 years after founding	4	4	0
3–5 years after founding	3	1	2
≥6 years after founding	3	0	3
No external financing	1	0	1

Source: Own data from interviews and from corporate web sites.
[a] Excludes seed financing but includes IPOs.

The motivation to turn to the IPO market for initial rounds of funding was to maintain control of strategic decision-making and avoid diluting equity. Perhaps unsurprisingly these three British hybrids had executive managers who all had prior experience in biotech start-ups and as a result successfully lead IPOs at a very early stage of firm development (within the first two years of founding). The other two hybrid DBFs, which spun out of universities with academic founders, relied first on venture capital funding, one of them raising more than £50 million in venture capital to finance drug discovery programs and was eventually acquired by a larger biotech firm. The other DBF has since lead a successful IPO once it was able to recruit industry-experienced managers.

The ability for British hybrids to raise external financing quickly after their founding (Table 5) also shows that British hybrids are able to focus and dedicate resources to drug discovery and development. In fact, the majority of their financial resources have been earmarked for developing new drug products. The revenue from their services was described as 'covering overhead', 'an early revenue stream', 'something to retreat to if the necessity arose'. The services business is a 'nice-to-have' revenue source, but not a *raison d'être*. Funding drug discovery and product development requires a large amount of financial capital[11] and only the very large pharmaceuticals that have deep pockets of retained earnings are able to finance this type of R&D from internal sources. Hybrid DBFs that earn marginal amounts of revenue from service activities cannot feasibly fund this type of activity with their revenue stream. Since a strategic objective of these hybrids is to bring a new

[10] The first round of financing refers to early stage funding in excess of £1 million or €1.5 million from external sources. All of the firms in the sample, in one way or another, raised seed financing from informal investor or government grants. The amount raised in seed financing is excluded from the first round of financing.

[11] In 2006 the average cost of drug development, from discovery to launch, was $1.2 billion.

therapeutic product to market, acquiring financial resources remained a critical activity for these firms. The evidence shows that British hybrids secured external funding quickly (Table 5) and they were generally much more 'product-focused' than service-oriented, in the sense that they were able to allocate resources and develop a therapeutic product rather quickly in addition to providing services for customers.

Raising a first round of external financing through initial public offerings represents a path that is primarily accessible in liberal market economies with liquid stock exchanges. Of the four British hybrids that floated without having raised any venture capital funding, three of them floated in the first year of founding. In order for these firms to follow this strategy, they had founding management teams with extensive industry experience. These managers found the public equity markets a more attractive financing path than involving venture capitalists. There were a couple of reasons for this. First, one of the advantages of involving venture capitalists is to gain access to the industry knowledge and managerial expertise provided by the VC or through their networks. Since the British biotechs were able to access and recruit industry and managerial experience in their founding management team, the additional benefit of the expertise of venture capitalists would be limited. Secondly, hybrids generate revenue and the immediate need to raise funding to continue operations is lower. If necessary, they are able to sustain their services business and delay the progress of drug programs. The founders of these DBFs also speculated that the combination of revenues (even though limited) with drug development was attractive to shareholders because it provided cash flow to cover operational overhead so that the funding raised through the IPO could be dedicated to drug programs. It also reduces some of the risk. If drug programs failed there would still be a business that offered some value to the shareholders.

Dutch hybrids gave different reasons for following hybrid strategies and their strategy tended to emerge from the contingent institutional conditions. In the data set, there are six Dutch DBFs that followed hybrid strategies at some point either as a founding model, as a present model or as a transitory model. Only two of these six DBFs have had stable models, having had a hybrid model at founding and presently still pursuing this strategy. A number of these DBFs cite the immediate need to generate sales for survival as the reason for pursuing a hybrid strategy.

> ". . .generating revenues was very important because it was obvious from the start that we could not and we didn't want to survive on VC money. During that period, economies were worse than now. Then VC money, we couldn't get that easily so we wanted to generate revenues to make sure we could survive in the long run."

> ". . .the model was very simple you get a contract and do the job. It was fee for service. That was at that time not the most popular concept and actually it was a concept that nobody, hardly anybody had tried before in this area. Everybody was at that time focused on new technologies and getting VCs on board as soon as possible. But in our case, VCs were not interested and the banks were not interested."

The immediate need for revenues was not the only reason to offer services. In a couple of the cases, a lack of technology or an insufficient knowledge of using the technology for discovery purposes was also a reason for Dutch DBFs to follow services models until they were able to identify drug targets and compounds. This process of experimentation was an important part of understanding the boundaries of their technology. Although the founders of the Dutch hybrids had perhaps ambitions to discover and develop drug products, they lacked the means, both financial and technological, to pursue this goal. Eventually, four of the six Dutch hybrids secured external financing from venture capitalists (Table 4) but none of these raised this first round of financing within the first two years of its founding (Table 5). In fact it took Dutch hybrids on average 5.5 years[12] to secure their first round of external financing. Obviously the *need* for external financing is a crucial factor in this difference. The Dutch hybrids may not have needed external financing for several years because they first followed services model in order to generate revenue as they searched for not only access to financial resources but also, possibly, technology on which to build a drug product pipeline.

One difference with the British cases is that Dutch hybrids did not access public equity markets for the first round of funding. A possible explanation for this is that the management in Dutch hybrids lacked experience in raising capital through public equity markets, the cumulative experience of most founding management teams in the Dutch cases being heavily academic. Additionally, for the DBFs that did successfully raise the first round of venture capital financing, the majority of these firms (three out of the four) accessed these resources internationally, essentially using functional equivalents to compensate for constraints in the national financial system.

4.2. Competence destruction and competence enhancement

Competence destruction or enhancement is generally associated with radical or incremental innovation, respectively. One of the arguments in the comparative capitalism literature is that certain configurations in the labor systems, e.g. high or low employment protection, general or specific skill development, encourages patterns of competence destruction or enhancement. Generally a low level of employment protection, coupled with general and transferable skills is associated with competence destruction and allows firms to engage in and adopt high-risk (radical) innovations more easily. The converse holds for competence enhancement, or accumulation, and low-risk (incremental) innovation. Given the differences between the British and Dutch labor systems, the expectation is that there is a higher level of competence destroying behavior in British DBFs than in Dutch DBFs, for which it follows that British DBFs would be engaging in more high-risk innovations.

I looked at competence destruction in the form of reconfiguring resources related to technological uncertainty or progress and not reconfiguration related to market changes or uncertainty. The ability to reconfigure resources implies that a firm has some flexibility to adapt to the uncertainty it faces and respond strategically. Among the sampled hybrid DBFs, the British hybrids reconfigured their resources more often. There were periods of building up resources, for example to develop a technology platform, followed by a contraction of resources when the project was finished or had progressed to a different stage. Among the British cases, there are two hybrids that experienced major reconfiguration of their resources. One of these started out primarily as a services-oriented DBF and after raising funding expanded their discovery division. Shortly thereafter, the managers and investors of the DBF realized that its informatics division had become unsustainable and unnecessary and reduced its workforce drastically in that area. Then a few years later, raising additional financing became difficult, and the investors and managers closed down the discovery division to make the DBF a more attractive acquisition based on its platform technology. The other British hybrid echoes this series of events; the DBF faced difficulties in raising financing and in this case, chose to divest its services division, selling off its contracts and platform. The money raised from the sale has been reinvested in to continuing

[12] This is a median average.

its lead drug program. In essence this hybrid DBF is now following a pure drug discovery model. These two examples show how British hybrids respond to technical uncertainty using external flexibility, or the firing of human resources when discontinuing activities.

From the sampled Dutch hybrids, there are no similar accounts of reconfiguration of resources. This is not to suggest that Dutch DBFs do not reorganize because there are a couple of cases where Dutch service-oriented DBFs reduced their workforce substantially because of a decrease in sales. However, reconfiguration of resources based on the progression of a project was absent among the cases. In most of the cases, Dutch hybrids followed a slow-growth path and instead of hiring specific resources for discovery projects, shared resources between customer service-based projects and internal drug discovery projects. In one account, a Dutch hybrid changed from a hybrid to a pure-discovery model. The process of shedding excess resources related to the platform technology was slow, based on attrition and took several years. The DBF did not specifically 'fire' resources but they changed their jobs and responsibilities, using internal flexibility, and in most cases these employees left on their own will.

From this discussion, it seems that competence destruction as associated with high-risk innovation strategies takes place more commonly among British hybrids than among Dutch hybrids. This suggests that British hybrids are more focused on high-risk strategies, where the resource requirements of technology or product development failure or progression are reconfigured through external flexibility. It also suggests that Dutch hybrids engage in more competence enhancement, low-risk strategies, accumulating knowledge and skills from their services activities and reallocating these resources among their activities. This accumulated knowledge provides learning advantages but the extent of learning depends on how extensively human resources are shared between services and drug discovery and development programs.

Looking at how the British and Dutch hybrids managed and allocated resources showed a substantial difference in coordination and control. The British hybrids emphasized the difficulty in managing the inherent conflict of interest of allocating resources to internal (drug discovery) or external (service) projects. British hybrids carefully defined the external boundaries as well as the internal boundaries of their services. All of the British hybrids elaborated on the difficulty of controlling and monitoring resources; some had more sophisticated monitoring routines and dedicated sets of resources while others were more informal or used shared resources. The following quotation highlights the balance of managing resources, 50% to internal and 50% to external projects.

> "[Customers tend to get priority, but this is] the reason we keep such good metrics so that we're able to analyze this ... this situation came along and we had to deliver and we did deliver. And, I thought, that must have burned up so much resources and then went back to the timesheets and looked and we're still keeping the 50/50 balance. So, it's got a bit of a buffer in it, the resource planning that we have."

For British hybrids, allocating resources to projects was not purely a matter of internal conflicts but also of external ones. A founder acknowledged that the hybrid model was successful but almost too successful, because as the firm gained recognition in the market, its discovery efforts created conflicts with customers:

> "... drug discovery came first but what happened is ... we had good awareness very quickly across the pharmaceutical world because of the contract research we put out there and we went to conferences and the profile was very high very quickly. People saw us as a contract research company and then once they saw there was also a bit of drug discovery in there that created a bit of conflict."

This theme of external customer conflict surfaced in other British hybrids as well. Another founder elaborated on their strategy:

> "... we look at orphan diseases where big pharma are not interested. So I've avoided again any conflicts because they know which diseases we're looking at and they're not looking at the same set. So they are happy. They don't feel that they cannot tell us anything. Orphan diseases are not big enough for big pharma; they are not going to make enough money. But to a small company like mine, an orphan disease is fantastic."

The founders and management of Dutch hybrids perceived the inherent conflict in this strategy quite differently than their British counterparts. Instead of managing the resource allocation for internal and external purposes, they referred to the potential learning benefits. One of the Dutch hybrid DBFs attributed the learning process as one of the advantages of licensing their technology and selling services; the iterative learning helped them to understand and discover the limitations of their technology and improved their own process of drug discovery and development.

Compared to British hybrids, Dutch hybrids experienced a transition process as they evolved from a services-oriented model to a more product-oriented one. Whereas in the UK, hybrids had the financing, skills and technology to start with discovery from the founding, the Dutch hybrids were involved in iterative learning processes to improve their technology for drug development purposes or they were involved in searching for in-licensing opportunities. The following quotation is illustrative of this search.

> "That was a continuous struggle. We started with an idea about products that failed. Then we refocused on other products that we stopped. Then we decided to focus on vaccines and acquired Firm A and had their antibodies and that failed. Eventually we settled on [our current programs] but that was very late after all the different reiterations. The one constant factor was the technology which was strong and increasingly generated revenue, not just revenue but also reputation for the company. But the best way for us to generate our own products and the struggle from being a platform technology company to [becoming] a product company was a very, very big one."

This particular hybrid had also been able to raise a substantial amount of external financing to fund this transition process from a 'platform to a product' company. However, one of its investors admittedly acknowledged that they probably invested too early in the company and that there were many years and a lot of effort spent on finding the right technology, drug programs and candidates. In this context of learning and experimentation, the accumulation of knowledge is necessary to progress and to, eventually, be successful in drug product development. Yet, often investors do not have the patience to fund this type of cumulative learning, especially for high-risk innovation. By also offering services, Dutch hybrids sustained their existence while engaging in long-term learning.

5. Theoretical implications of the hybrid model

This deeper investigation into the differences between British and Dutch hybrids provides insight into why these models are followed. Table 6 summarizes the main characteristics of the hybrid models in each country. In the Netherlands one is quick to assume that the hybrid model is used to compensate for the lack of available private and public equity; yet this deeper investigation has shown that learning is a key element for pursuing this strategy. It also suggests that Dutch founders start hybrid DBFs based on younger, less 'ripe' platform technologies and through an iterative

Table 6
Characteristics of financing, governance and capability development of the biotech hybrid model.

	UK	NL
Financing	Internal Public Equity/IPO	Internal (International) VC/CVC
Corporate governance	Outsider to insider dominated	Insider dominated
Organizational learning mechanisms	Dedicated resources for drug development and services Limited drug development learning from customers	Shared resources for drug development and services High drug development learning from customers
Reconfiguration capability	High; external flexibility (hire-and-fire; divestment of business units)	High functional (internal) flexibility

learning process improve their technology while also learning drug development skills, a time-consuming and costly process. Another important implication of this analysis on the hybrid model is that it shows that the Dutch labor and skills systems have indeed promoted skills that support knowledge and skill accumulation, as the majority of these hybrids start with a services-oriented strategy, regardless whether it is based on proprietary or generic technology and grow into discovery or hybrid models (Casper and Kettler, 2001).

The evidence on the British hybrids suggests that the British national financing system encourages the prevalence of discovery-oriented models through its inherent institutional selection mechanisms and isomorphic processes (DiMaggio and Powell, 1983; Meyer and Rowan, 1977). As new firms enter the market, they follow the patterns of the successful firms before them, creating a shared understanding of what is 'successful' and a dominant institutional logic in the organizational field (Battilana, 2006). In the British biotechnology sector, the financial system perpetuates the use of the discovery model, encouraging firms to engage in high-risk innovation strategies and providing financial capital and governance for investments in high-risk innovation. The flexibility and mobility in the labor system also complements the financial system in supporting high-risk innovation strategies.

In the case of the Netherlands, it is expected that the financial system deters Dutch DBFs from following high-risk innovation strategies; yet, a number of service-oriented DBFs have transitioned to more discovery-oriented models in an attempt to create more value in the firm and follow the dominant logic of the organizational field. The constraints that Dutch DBF founders face in the financial system have encouraged Dutch entrepreneurs to follow alternative paths to funding by accessing venture capital on a transnational level and in essence created a functional equivalent to their national financial system. Dutch founders also used the services model as a transitional strategy while they searched for appropriate platforms and knowledge to acquire in order to pursue more high-risk strategies in drug development. All of these DBFs, except for one, maintained their services division once they had acquired the resources to engage in drug product development. Even though the Dutch institutional systems encourage investment in low-risk innovation, Dutch founders of DBFs in an attempt to follow the institutional logics of this international sector transitioned to more high-risk innovation strategies. This raises the question then if the hybrid model is a form of innovation strategy for which the Dutch systems provide comparative institutional advantage and one which, given the current debate of the nature of innovation in drug development (Pisano, 2006), provides advantages by emphasizing learning over short-term performance. Or, is it a transitional strategy that will give way to either a focus on products or services.

The in-depth analysis on the hybrid model has revealed a much more important aspect in regards to following high-risk or low-risk innovation strategies and that is the Dutch DBFs' ability to reconfigure human resources not just access them. It can be assumed that as hybrids grow and transition between activities, substantial reconfiguration of resources takes place. Reconfiguration or dynamic capabilities are essential competences for DBFs following high-risk innovation strategies, as they need to be able to respond and adapt to the uncertainty of their technology (Teece et al., 1997). The analysis of the hybrid models in both the UK and Netherlands uncovered the subtleties of the national influences on the development of organizational capabilities, showing that certain regulations and institutions affect competence enhancement or competence destruction. The findings show that the Dutch institutional context limited the external flexibility (hire-and-fire) of firms and that Dutch DBFs relied on internal functional flexibility to reconfigure resources.

The mechanisms of internal flexibility that firms in coordinated market economies have developed may provide comparative advantages in the integration of new resources with existing ones. However, the important question to ask is, does it matter whether resource reconfiguration takes place through external or internal flexibility, or put into other words, is competence-destroying behavior more beneficial to high-risk innovation than competence-enhancing behavior. If there is any truth to the argument that radical breakthroughs rely on a series of incremental innovations leading up to it, then logically there is also an argument that competence-enhancing behavior is beneficial to radical innovation. The findings in this paper are only a possible explanation of how DBFs in CMEs change or reconfigure resources in order to focus on or adapt to high-risk innovation. Much more research is needed to fully understand organizational capability development in regards to innovation strategies and whether institutional configurations that encourage long-term employment and therefore competence accumulation provide comparative institutional advantages for DBFs following high-risk innovation strategies in the biopharmaceutical industry.

6. Conclusion

This study explains how firms adopted alternative strategies to focus on high-risk innovation when faced with institutional constraints and how firms follow strategies consistent with the dominant logic of the organizational field. As institutional complementarities sustain the use of a set of institutional systems from which benefits are derived, scholars have claimed that changing parts of an institutional system may have adverse affects on the efficiency of the whole system (Crouch, 2005; Hage and Meeus, 2006; Morgan et al., 2005; Oliver, 1991; Thelen, 2003, 2004). Yet, as Crouch (2005) argues institutional heterogeneity within institutional systems is necessary for institutional change to take place. Without it institutional entrepreneurs would have no alternative paths to follow and would not be able to provide innovative ways of coordinating or organizing economic activity. In this perspective the Dutch example shows how entrepreneurs recombined elements of coordinated market economies to provide firms with new paths to follow. The biotech hybrid model seems to be an example of how institutional entrepreneurs are recombining institutional elements but given the limited use of this model in the biotech industry, the extent of institutional change remains to be seen.

This study contributes to the extant literature on comparative capitalism by providing a firm level analysis of the transition between high and low risk innovation strategies and by offering an

initial understanding of the firm level influences of institutional entrepreneurship. Given the fact that governments, particularly those in Europe, are investing substantially in schemes to stimulate the growth of biotechnology clusters, a deeper understanding of the supportive institutional systems is needed. The general assumption of government policy is that the Silicon-Valley model is importable; yet very few regions have been able to duplicate it successfully and it is being questioned if the Silicon-Valley model is indeed a sustainable model for biotechs. In this sense, the study also aims to inform policy makers in their efforts to 'orchestrate' biotechnology clusters.

As a case study, this study is not intended to make inferences to a larger population. However, considering it is intended to be an industry specific case, it does have a certain amount generalization. First, the constructs of the ideal types, or business models, were based on a larger sample. The study was also designed to provide insight into the specific hybrid model, for which the eleven cases represent 50% of all identified hybrids in the UK and Netherlands. However, the hybrid model should be viewed as an exceptional model and as such inferences to the larger biotechnology industry are limited. Another limitation is the possibility of sample bias since only DBFs that have survived could be interviewed. However, since the time of data collection a number of firms a couple of the British hybrids have been acquired or liquated and now cease to exist in the same form in which they were interviewed. This provides some perspectives on the firm development and outcomes of the hybrid model. A final limitation is that data was gathered retrospectively and respondents may have rationalized the events or interpreted the events differently over time.

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Appendix A.

List of DBFs included in the sample and job titles of respondents.

	Date founded	Number of founders	Origin of technology	Model at founding	Model in 2006	Nr. employees within first year of founding	Nr. employees in 2006	Type of first round founding	Year of first round founding	Nr. of VC financing rounds to date in 2006*	Public or private (2007)	Job title of respondent
UK												
UKH01	2003	3	IND	H	H	8	30	IPO	2004	0	PUB	CSO (founder)
UKH02	2001	2	UNIV	H	H	5	30	VC	2005	1	PUB	CEO (founder)
UKH03	2003	3	IND	H	H	10	40	IPO	2004	0	PUB	CEO; founding scientist
UKH04	1998	1	UNIV	H	TSP	24	24	VC	1999	3	Acquired in 2006	CSO; CFO
UKH05	2004	1	UNIV	H	H	25	25	IPO	2005	0	PUB	CEO; CSO (founder)
Netherlands												
NLH01	1999	2	UNIV	TSP	H	0	27	Rev	None	0	PRIV	CEO; CSO
NLH02	1995	2	UNIV	TSP	H	4	125	VC	2005	1	PUB	Founding scientist (prior CSO)
NLH03	1992	1	UNIV	H	H	10	>500	VC	1996	3	PUB	Founding scientist (prior CEO)
NLH04	2003	3	IND	H	TSP	8	8	Rev	None	0	PRIV	CEO (founder)
NLH05	1997	4	UNIV	TSP	D	0	25	VC	2001	3	PRIV	CFO
NLH06	1998	1	IND	11	11	1	>500	Rev, VC	2002	1	PUB	Founder

Origin: UNIV, university department, research institute; IND, (bio)pharmaceutical, other firms.
Model: TSP, technology service providers; D, discovery; H, hybrid.
Type of funding: VC, venture capital; Rev, revenue from sales; IPO, initial public offering.
Ownership: PRIV, private ownership; PUB, public listed company.

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