Manchester Metropolitan University
Business School

Working Paper Series

Working Paper 07-02

Interrelationships between Exploration and Exploitation in Complementary Domains of Knowledge: An Empirical Study of Co-operative Agreements in the UK Biotechnology Sector

Despoina Filiou
Manchester Metropolitan University Business School
Aytoun Building
Aytoun Street
Manchester
M1 3GH
United Kingdom

ISSN 1478-8209

Interrelationships between Exploration and Exploitation in Complementary Domains of Knowledge: An Empirical Study of Co-operative Agreements in the UK Biotechnology Sector

Manchester Metropolitan University Business School Working Paper 07-02

Despoina Filiou
Manchester Metropolitan University Business School
d.filiou@mmu.ac.uk

2007

ABSTRACT

Within the knowledge-based view firms co-operate because they are motivated either by a desire to access or to acquire capabilities. This paper combines these two aspects by drawing on the literature on distributed innovation processes as well as that on dynamic capabilities. It contends that firms co-operate because they are motivated by the desire to gain access to complementary capabilities and to match internal explorative and exploitative search with their external counterparts that are present in complementary domains of knowledge. The contention is examined empirically within the UK's biotechnology sector. Specifically, it is suggested that dedicated biotechnology firms co-operate primarily because they wish to exploit technological capabilities that are matched with exploration of knowledge in demand. Established firms co-operate primarily because they seek first to exploit demand capabilities, and second to engage in the exploration for, and the beneficial use of technological knowledge. The findings help our understanding not only of the motives behind inter-firm co-operation, but also of the way in which co-operative agreements can be initiated and managed in their nascent phases.

Keywords: biotechnology, co-operative agreements, exploitation, exploration

1. Introduction

The 1980s and particularly the 1990s have been characterized by a marked increase in the number of inter-institutional co-operative agreements that involve partners located within different countries and industries (Kang and Sakai, 2000; Hagedoorn, 2002; Hagedoorn and Roijakkers, 2006). Inter-institutional co-operation is not a new phenomenon. It has been argued that the features that differentiate the recent trend towards increased co-operation from that experienced in the 1920s and 1930s are its extent and, most importantly, the desire amongst firms to co-operate in order to innovate (Coombs *et al.*, 1996; Coombs and Metcalfe, 2000; OECD, 2001; Contractor and Lorange, 2002). In the current knowledge-based economy the abilities of firms to create new knowledge have come to occupy centre stage. It is these abilities that underlie their, and nations', competitiveness (OECD, 1996; 2001).

The literature that draws on the knowledge-based view argues that firms co-operate because they wish to acquire, or to gain access to, the knowledge and capabilities of their partners (e.g. Lane and Lubatkin, 1998; Contractor *et al.*, 2002; Grant and Baden-Fuller, 2004; Holmqvist, 2004). Acquisition of knowledge through co-operation can lead partners to learn, whilst gaining access to knowledge through co-operation can result in partners' specializing (Mowery *et al.*, 1996).

This paper contributes to the literature that seeks to explain firms' motivations in engaging in inter-firm collaboration. It does so by synthesizing the knowledge-access and acquisition, or learning approaches. The paper posits that there are important interrelationships between firm motives to access capabilities and to engage in learning through co-operation that are not addressed by considering these streams of literature alone. The paper derives specific propositions on the motives behind firms' desires to co-operate. This is done by exploring the type of and the potential interrelationships between the capabilities and search, or learning, processes involved in co-operative agreements. These propositions are built on arguments espoused within the literature, first, on distributed innovation processes (Coombs and Metcalfe,

2000; Coombs *et al.*, 2003), and second, on dynamic capabilities (Teece and Pisano, 1994; Teece *et al.*, 1994; Teece *et al.*, 1997; Koza and Lewin, 1998; Dosi *et al.*, 2000; Zahra *et al.*, 2006).

The empirical exploration of these propositions uses principal component analysis. It draws on an original longitudinal dataset of co-operative agreements initiated by firms in the UK biotechnology sector between 1991 and 2001. Biotechnology, defined as a set of techniques for the manipulation of living organisms, stemmed from, and is intertwined with science (Kenney, 1986; Orsenigo, 1989). It witnesses a range of applications in established industries, such as pharmaceuticals, chemicals and agriculture (Walsh, 1993; Powell, 1996; Saviotti, 1998). Many start-up companies (the so-called dedicated biotechnology firms) were formed, mainly as university spin-offs, to take advantage of these opportunities for commercialization. Incumbent firms were involved in the commercialization of biotechnologies mainly through co-operative agreements. In this sector, inter-institutional co-operation is not only prominent (Hagedoorn, 2002; Hagedoorn and Roijakkers, 2006) but is also becoming the main avenue for innovation (Powell *et al.*, 1996). Both actors, dedicated biotechnology firms and established firms, in this sector have motives to co-operate that may be underpinned by different desires (e.g. Smith *et al.*, 1991). The focus of this paper is placed on the UK biotechnology sector not only because of its international prominence, being second only to the US in terms of innovative output (Van Beuzekom, 2001), but also because this sector in the UK is relatively under-researched compared to that of the US.

Therefore, this paper's contributions are twofold. On a theoretical level, it contributes to our existing understanding of the motives behind firms' desires to co-operate by combining the knowledge-access and acquisition approaches of the knowledge-based view. On the empirical level, it complements and extends the existing body of research in two main ways. It is one of the few studies that draws on a large-scale dataset to examine the motives behind inter-firm collaboration. This analysis, moreover, focuses on a highly important, yet under-researched

economic sector: that is, the UK's biotechnology sector. This paper also seeks to use a methodology that is an alternative, yet complementary way to related studies. The findings also have implications for the management of co-operative agreements and for our understanding of the interdependencies that may arise between co-operating organizations.

The paper is structured as follows. Section 2 discusses the emerging literature on distributed innovation processes, its insights on the reasons underlying co-operation and the types of capabilities that firms will aim at accessing through co-operation. Section 3 reviews the dynamic capabilities view on firms' motives for co-operation. It also discusses how this view assists the generation of expectations on the type of search processes that firms undertake when seeking to co-operate. Section 4 combines these two steams of literature and puts forward proposals on the motives behind firms' desires to co-operate. Section 5 presents the data sources, the methodological issues, and the treatment of the data for the empirical examination of the firms' motives. Section 6 presents and discusses the empirical findings. Section 7 concludes the paper and provides suggestions for further research.

2. Motives for Co-operation: The Distributed Innovation Processes Approach

The emerging literature on distributed innovation processes argues that innovation and production processes are increasingly becoming the outcome of the interaction and co-operation of a diverse range of agents. This places the understanding of, the reasons for, and implications of inter-firm co-operation at centre stage (Coombs *et al.*, 2003). The main reason underlying this 'distributedness' (Coombs *et al.*, 2003) is the increasing sophistication of products and processes that demand the combination of an increasingly wider scope of knowledge (Brusoni *et al.*, 2001; Brusoni and Prencipe, 2001).

One implication of this is that firms face increasing constraints on their abilities to retain competencies in all aspects of the knowledge that need to be combined if innovations are to be forthcoming. This gives rise to the need amongst firms to co-ordinate, using organisational

forms, the innovation and production process (Coombs *et al.*, 2003; Valentin and Jensen, 2003; Acha and Cusmano, 2005). Firms will tend to retain aspects of knowledge that underpin most of their products. They will seek to access by using various organisational forms, such as co-operative agreements, those aspects of knowledge that complement their existing knowledge (Grant and Baden-Fuller, 2004). The knowledge that underlies the production and innovation process can fall within two broad domains, technology and demand, that are complementary (Malerba and Orsenigo, 2000). Knowledge across these domains requires dissimilar activities. Thus, they are likely to be distributed across firms (Richardson, 1972).

Moreover, in a distributed knowledge environment, the aspects of knowledge that firms competently retain are likely to be under-utilized internally. This provides firms with a motive to trade-off their independence for a more efficient management and use of their internal knowledge. This means that firms will have reasons, first, to access from beyond the firm's boundaries aspects of knowledge that underpin their production processes and, second, to allow their internal knowledge to be accessed by other institutions in an attempt to manage and use internal knowledge more effectively (Grant and Baden-Fuller, 2004). Some of the fundamental attributes of knowledge, such as its indivisible nature, its increasingly wider scope of application, and the experience of economies of scale in its use, further reinforce this argument (Nelson and Winter, 1982; Grant, 1996).

The need to access complementary capabilities through co-operation for the commercialization of inventions has been put forward by Teece (1986). The premises of Teece's work (1986) spurned a stream of research relating the notion of complementarity to the capabilities of the collaborators (Greis *et al.*, 1995; Rothaermel, 2001; King *et al.*, 2003). Although King *et al.*'s (2003) work develops a theoretical framework based on complementarity to understand co-operation and the resulting interdependencies between large and small firms in technology-based industries, the relatively thin empirical evidence identifies, *inter alia*,

complementarity in the assets of co-operating firms for US dedicated biotechnology and established firms in pharmaceuticals (Greis *et al.*, 1995; Rothaermel, 2001).

3. Motives for Co-operation: The Dynamic Capabilities Approach

Organisational learning has been approached in the literature from various perspectives that derive from different theoretical antecedents. These differences are also reflected in the approaches taken within the literature that focuses on learning through co-operation (e.g. Mowery *et al.*, 1996; Lane and Lubatkin, 1998; Lane *et al.*, 2001; Inkpen, 2002; Mowery *et al.*, 2002). This paper focuses on the approach within organizational learning that is nested within the dynamic capabilities literature (Teece and Pisano, 1994; Teece *et al.*, 1997; Dosi *et al.*, 2000; Winter, 2003; Zahra *et al.*, 2006). This perspective is, in turn, embedded within the evolutionary theory of the firm literature (Nelson and Winter, 1977; 1982). There is a plethora of competing definitions for the term 'dynamic capabilities' (e.g. Dosi *et al.*, 2000; Zahra *et al.*, 2006). Despite this, dynamic capabilities refer, in general, to the deliberate processes that lead to the development of organizational knowledge, their association to superior performance and to turbulent environments is not necessarily justified (Zahra *et al.*, 2006).

An important part of the literature on dynamic capabilities focuses on the ways in which they are developed within firms (e.g. Zollo and Winter, 2002). Dynamic capabilities can arise through firms' investing in search processes for exploitation and exploration (Zollo and Winter, 2002). Exploitation is viewed as any process that replicates, refines and builds on the existing knowledge of firms. Exploration is seen as the generation of new ideas that arise by engaging in searches that seek to gain information and knowledge that is relatively new to the existing knowledge of the organization (March, 1991). Exploitation and exploration, which make up firms' dynamic capabilities, have been cited as motives that encourage firms to co-operate (Koza and Lewin, 1998). This paper draws on the literature on dynamic capabilities to link firms' motivations for co-operating to the types of search processes that firms intend to engage

upon when they seek to co-operate. In this way, this paper is not concerned with the outcomes of these capabilities, which may be reflected in firm performance or in the firm's development of knowledge, but with their creation.

A relatively thin stream of research that links inter-organizational learning to intra-organizational learning, or search processes, argues and empirically identifies linkages and inter-dependencies among these processes (Holmqvist, 2003; 2004). Specifically it is identified that exploration within organizations may form a prerequisite for inter-organizational exploitation, and *vice versa.* This suggests that these processes could be intertwined in a cyclical manner that parallels arguments regarding knowledge development within firms (Zollo and Winter, 2002).

Recent research on co-operative agreements argues that they may offer a means by which the inherent tensions between exploration and exploitation (March, 1991; Levinthal and March, 1993) may be overcome as they allow for their spatial separation (Lavie and Rosenkopf, 2006). Exploration and exploitation can occur in three different domains: the function of the agreement, its structure, and the relative attributes of partners (Lavie and Rosenkopf, 2006). For example, based on their function, downstream co-operative agreements are seen to be motivated by exploitation and upstream for exploration (Koza and Lewin, 1998; Rothaermel, 2001; Rothaermel and Deeds, 2004), whilst a recursive relationship may exist between the two types of agreements through their links to products under development (Rothaermel and Deeds, 2004). Moreover, exploration and exploitation along these three domains of co-operative agreements are found to be interdependent. Indeed, research on US software firms shows that these firms balance exploitation and exploration across the three dimensions contemporaneously and within each dimension over time (Lavie and Rosenkopf, 2006). This stream of literature has not addressed in detail yet the potential interrelationships between exploration and exploitation in cases that co-operative agreements bring together complementary capabilities.

4. Motives for Co-operation: Insights Obtained by Synthesizing the Distributed Innovation Processes Approach and the Dynamic Capabilities Perspective

As shown above, the distributed innovation processes literature provides insights into the relationships that exist between the different capabilities that firms will seek to access through co-operation. The dynamic capabilities literature sheds light on the type of search, or learning, processes that can motivate firms to co-operation. This paper contributes to our existing understanding of what the motives are behind firms' decisions to co-operation. It does so by synthesizing these approaches and by proposing that motives to access specific types of capabilities will be interrelated with desires to engage upon specific types of search processes. Specifically, it proposes that firms will be motivated to co-operation to link their internal search efforts in exploration and exploitation to their external counterparts that are present in complementary and distributed domains of knowledge. The existence of such interdependencies cannot be explored by using either the knowledge-access (distributed innovation processes approach) or the knowledge-acquisition, or learning, approaches (dynamic capabilities) alone.

A parallel argument is made in Gupta *et al.* (2006) on the specialization of firms in exploration and exploitation and the matching of their search processes through co-operation. It is suggested that exploration and exploitation can effectively be balanced in systems of organizations when co-operating partners, A and B, possess complementary capabilities (*ibid.*). In that case, Gupta *et al.* (2006: 699) argued that the two partners can specialize in one of the two search processes because complementarity ensures that:

> the output of A's exploration is not entirely wasted and the promising ideas can be handed over to B for exploitation. Conversely, even though B focuses solely on exploitation, it has a constant supply of radically new ideas available from A.

Although Gupta *et al.* (2006) argue that organizations may specialize in exploration or exploitation when operating in systems, in this paper we do not attempt to find support for this proposition in general; on the contrary, we propose that organizations can specialize in

exploration or exploitation within the context of a given co-operative agreement when it brings together complementary capabilities.

Table 1 provides an approximation to the domains of knowledge and types of resources that can be accessed through co-operation and the type of search processes that firms that are motivated to initiate co-operative agreements will engage in. By concentrating on the knowledge-based view of the firm, this paper suggests that exploration and exploitation can occur in the technological and demand domains of knowledge, or in their intersections, of a firm's knowledge base. Exploration and exploitation are identified through the direction of flows in co-operative agreements, with unidirectional agreements reflecting motives for either exploitation or exploration (Hagedoorn and Schakenraad, 1994), and bi-directional agreements reflecting motives for both exploration and exploitation (Lazaric and Marengo, 2000).

Table 1 Type of Capabilities and Search Processes

Domains of Knowledge/Types of Resources	Search Processes		
	Exploration	Exploitation	Exploration & Exploitation
Technological (e.g. Licensing)	√	√	√
Demand (e.g. Marketing)	√	√	√
Other (e.g. Finance)			
Combinations (e.g. Research and Development)	√	√	√

Notes: Denoted are those of the domains of knowledge or resources and types of search processes that could be involved in cooperative agreements that are captured in this paper.

5. Data Sources and Methodological Considerations

5.1 Data Sources

Firms in the UK biotechnology sector are identified through the UK Biotechnology Directory, and other sources, such as the Bio-Industry Association, which list firms that produce goods or services using biotechnology processes, or that are involved in research in these areas (Coombs

and Alston, 2000; 2002). A 110 firms form the sample, which includes all major dedicated biotechnology firms (share in total, 24.4 per cent) and the incumbent firms, such as those in pharmaceuticals and chemicals (24.9 per cent). The remaining half of the sample includes firms classified in industries other than the above (e.g. 'other non-classified businesses', 'other service activities' and 'other manufacturing activities'). Some of the firms in the sample are multinational enterprises.

Following other studies (Arora and Gambardella, 1990; Pisano, 1990; Deeds and Hill, 1996; George *et al.*, 2002), we derive our information on co-operative agreements from two sector-specific databases, ReCap.com and BioScan, that draw on press releases, sector-specific magazines, and company annual reports, reporting information dating back to 1979. The sample of co-operative agreements includes 2,418 agreements formed by the firms in the sample from 1991 to 2001 with UK-based or international institutions (accounting for 87 per cent of all agreements formed in the sector between 1979 and 2001). The paper focuses on this time period due to the immense upsurge in co-operative agreements witnessed in that period, not only in biotechnology (Hagedoorn, 2002; Hagedoorn and Roijakkers, 2006) but also in general (Kang and Sakai, 2000).

5.2 Empirically Exploring Firms' Motives to Co-operate

This paper uses the content of co-operative agreements and the role that each partner assumes in the co-operation to develop a set of empirical constructs that could capture firms' motives for co-operation from a knowledge-based point of view. Therefore, unlike other studies (Greis *et al.*, 1995; Rothaermel, 2001; Rothaermel and Deeds, 2004) that concentrate on the value chain function of alliances and their relationship to the existing competencies of firms to identify exploratory and exploitative motives and complementarities, this paper concentrates on the content of the agreement and the intentions of firms to use internal knowledge or to gain exposure to external knowledge through co-operation. By concentrating on the content of each

agreement, this paper avoids making assumptions on the type of capabilities that firms have prior to a co-operative agreement. It is being also able to explore potential interrelationships in capabilities and search processes in these agreements. In this way, this paper offers an alternative, yet complementary, methodological approach to those of existing studies.

This paper uses the categorization of knowledge domains and capabilities between technology and demand (Malerba and Orsenigo, 2000) which complement each other in the innovation process (Rothwell, 1992). Agreements that involve research, technological co-operation, the exchange of technological material and licensing are taken to denote engagement of knowledge in technological domains. Agreements for manufacturing, marketing, distribution and product development reflect engagement of knowledge within the demand domain.

The role that each partner assumes in the agreement and its directionality are taken to reflect whether they are a) attempting to use their expertise in that agreement (to engage in exploitation), b) seeking to gain exposure to their partners' expertise(s) (to engage in exploration), and c) aiming at pursuing both exploration and exploitation at the same time. The use of directionality to make conjunctures on motives for using or attracting knowledge in co-operative agreements follows that of other studies (Hagedoorn and Schakenraad, 1994). Unlike Hagedoorn and Schakenraad's (1994) study that eliminates bi-directional agreements, this paper considers these agreements to denote that a single partner is aiming at both exploitation and exploration as identified elsewhere (Lazaric and Marengo, 2000). Table 2 illustrates the treatment of content and directionality in deriving the empirical constructs that capture firms' motives for co-operation.

Table 2 Identification of Firm's Potential Motives for Co-operation based on Content Analysis and the Role that Partners Assume in Co-operative Agreements

Content of Co-operative Agreements	Potential Motives					
	Domains of Knowledge/Capabilities					
	Technology			*Demand*		
	Exploration	Exploitation	Both	Exploration	Exploitation	Both
T1. Research			√			
T2.Technological collaboration			√			
T3. Licence, sub-licence	In	Out				
T4. Cross-licence			√			
T5. Supply of technological material	In	Out				
D1. Development				Out	In	
D2. Marketing, promotion				Out	In	
D3. Manufacturing				Out	In	
D4. Co-development, co-promotion, co-market						√
T & D. Mergers, joint ventures			√			√
T &/or D. Acquisitions, asset purchase	In	Out		In	Out	

In order to identify support for the propositions on firms' motives for co-operation outlined in this paper, there is a need to explore the existence and type of interrelationships of the empirical constructs in co-operative agreements. Such interrelationships can be reflected in the ways that these constructs correlate to one another. They can be identified by techniques such as principal component analysis (PCA) that are commonly used to capture general patterns and styles of firm behaviour (e.g. Coombs and Tomlinson, 1998). Moreover, in order to explore differences in the motives for co-operation between dedicated biotechnology firms and firms in established industries as suggested in the literature (Orsenigo, 1989; Smith *et al.*, 1991; Powell, 1996), PCA is employed separately for each industrial group in the sample.

Principal component analysis leads to a solution with fewer variables than the original constructs, which is defined by a combination of the conventional criteria, such as Kaiser's

(1960) and Joliffe's (1972) criteria (retain components with eigenvalues greater than 1 or 0.7, respectively) and Cattell's (1966) Scree Plot. The derived components reflect the ways that firms combine their search processes, exploration and exploitation, with domains of knowledge in co-operative agreements, and their interpretation is based on the original constructs that contribute most in composing them in relation to the remaining original constructs. Original constructs with weights above 0.4 have been considered as the most meaningful contributors in making up components (Stevens, 1992).

6. Empirical Findings and Discussion of Firm Motives to Co-operation

The empirical constructs capturing firm motives to co-operation are found to correlate highly in clusters (correlation matrices can be found in the Appendix). Therefore there is a first indication that there are interdependencies among our constructs suggesting their co-existence within the co-operative agreements established by firms in our sample. The pattern and strength of correlations vary, based on the type of industrial group, indicating that the original constructs interrelate differently across these industrial groups, and suggesting potential differences in their patterns and motives for co-operation being in line with existing literature (e.g. Orsenigo, 1989; Smith *et al.*, 1991). Moreover, the correlation matrices show high degrees of pair-wise correlations (as suggested by the highly significant values of the Determinant statistic) among most of the original constructs. The significant values of the KMO (Kaiser-Meyer-Olkin) statistics and of Bartlett's test suggest that the sample is suitable for applying PCA (Kaiser, 1970, 1974; Dunteman, 1994). Table 3 presents the results when PCA is applied separately for each industrial group.

Table 3 Retained Principal Components across Industrial Groups of Firms from 1991 until 2001

Initial Variables	Industrial Groups of Firms							
	Dedicated Biotech			Pharma'cals & Chemicals		Other Industries		
	Retained Components			Retained Components		Retained Components		
Technology exploration	0.40	**0.74**	0.09	**0.86**	0.19	0.29	0.25	**0.68**
Technology exploitation	**0.74**	0.12	0.37	0.23	**0.82**	0.02	**0.90**	0.03
Technology exploration & exploitation	0.25	0.06	**0.74**	**0.80**	0.28	**0.83**	0.15	0.05
Demand exploration	**0.9**	0.07	0.09	0.11	**0.89**	**0.55**	**0.63**	0.04
Demand exploitation	-0.07	**0.90**	0.16	**0.88**	-0.00	**0.83**	0.02	0.20
Demand exploration & exploitation	0.08	0.16	**0.80**	**0.73**	0.26	0.00	-0.12	**0.88**
Number of observations[a]			**168**		**210**			**140**
Eigenvalues	1.639	1.415	1.367	2.740	1.663	1.755	1.305	1.283
Percentage of variance	27.31	23.58	22.79	45.67	27.71	29.24	21.75	21.38
Cumulative % of variance		50.89	73.68		73.38		50.99	72.37

Notes: Information on the complete set of components derived by principal component analysis is available upon request from the author.

a) The number of observations per industrial group of firms is less than the total number of co-operative agreements formed by this group because firms may form more than one co-operative agreement in a single year.

Each column of Table 3 provides a different reason (principal component) that leads firms to co-operation, explained by the original constructs that contribute more than 0.4 in making up that component. The first component of DBFs, for instance, shows that a reason leading these firms to co-operation is the exploitation of technology (weight 0.74) coupled with the exploration of demand capabilities (weight 0.9). The diagnostic statistics show that all components interpret more variance than a single one of the original constructs (eigenvalues greater than 1), and cumulatively they manage to interpret more than 72 per cent of the original variance across all industrial groups. However, Table 3 provides only the weights of the original constructs in creating components, and Table 4 is used to substantiate these findings, aiding their interpretation, by showing the magnitude of each of the original constructs in the total number of co-operative agreements formed by each industrial group. Before discussing the

findings, it should be noted that due to the nature of the study, only inferences of firm motives for co-operation can be made and while the findings may fit with existing literature, strong associations between them should be eluded.

Table 4 Variables Capturing Motives for Co-operation and Appearance in Co-operative Agreements formed across Industrial Groups of Firms (1991 – 2001)

Initial Variables	Industrial Groups of Firms					
	Dedicated Biotechnology		Pharmaceuticals & Chemicals		Other Industries	
	Number of instances	Per cent of total	Number of instances	Per cent of total	Number of instances	Per cent of total
Technology Exploration & Exploitation	254	29.50	507	24.25	116	24.07
Technology Exploration	122	14.15	518	24.77	92	19.09
Technology Exploitation	169	19.60	208	9.95	75	15.56
Demand Exploration & Exploitation	78	9.05	309	14.78	73	15.14
Demand Exploration	145	16.82	211	10.09	78	16.18
Demand Exploitation	94	10.90	338	16.16	48	9.96
Total	**862**	**100**	**2091**	**100**	**482**	**100**

Note: The total number of constructs exceeds the total number of co-operative agreements formed by each industrial group, because the constructs are not mutually exclusive and a single co-operative agreement can incorporate more than one of them. The total number of constructs (reported as number of instances) is used to estimate the shares of initial variables in identifying the most popular motives for co-operation across industrial groups.

It is observed that the first and third component for DBFs and the first component for established firms include those of the initial variables most commonly appearing in the co-operative agreements formed by firms in these two groups. Therefore, it could be suggested that the main reason leading DBFs to co-operation involves the exploitation of their technological capabilities, which is coupled with the exploration of the demand capabilities of their partners.

Another popular tendency for DBFs (see third component in Tables 3 and 4) is to form agreements that include the above motives but that are, in addition, bidirectional in nature, potentially indicating a greater involvement on their part in determining the directions that these co-operative activities would take, for example in co-development agreements. Either way, our results propose that DBFs would be mainly driven into co-operation for exploiting their internal technological capabilities in directions likely to differ from those feasible internally, and that could stem from the variation and the new ideas that could come up by combining them with complementary capabilities in demand of their partnering institutions.

The first derived component for established firms (see Table 3) comprises three of the original constructs that are most commonly appearing in their co-operative agreements (Table 4), and it is likely to reflect the most popular reason for leading them to co-operation. The findings suggest that established firms co-operate primarily to undertake exploratory search in technological domains of knowledge, and for the exploitation of their demand capabilities. Exploratory search is often undertaken in bidirectional agreements, with established firms co-determining the directions of search and engaging their existing technological competencies in this. Established firms seem to be seeking through co-operation their exposure to new technological capabilities likely to relate to new biotechnologies, considering that our dataset contains co-operative agreements in biotechnology. Moreover, established firms seem to be taking advantage of the opportunities to use their existing demand-related capabilities by undertaking downstream activities for the development, manufacture and subsequent distribution of prototype products or technologies.

As other studies have shown, at the same time as the emergence of new biotechnologies, established firms were faced with underutilized manufacturing and marketing capabilities because of the decreases in the productivity of their drug discovering techniques (Walsh and Rodorfors, 2002; Nightingale, 2000). The need to further utilize these demand-related capabilities formed a popular motive for them to form co-operative agreements (Walsh, 1993;

Powell, 1996). This paper finds that, in conjunction with that purpose, established firms seem to be aiming at exploring the potential of the new biotechnologies and, at the same time, showing as high a tendency to combine technological exploration with the exploitation of their technological capabilities. The latter finding may reflect the potential complementarities that are likely to exist among different technological competencies, and that have been empirically identified in some applications within bio-pharmaceuticals. Indeed, studies on the cardio-vascular drug discovery process have shown that new biotechnologies are used together with other technologies, and more traditional scientific disciplines and techniques (Henderson, 1994). The reasons leading firms in other industries to co-operation follow a comparatively more mixed pattern. Discussions in this paper concentrate on dedicated biotechnology firms and those in established industries because they form the type of actors whose interrelationships are mostly of interest.

There are some general patterns in the reasons leading firms to co-operation that appear across components and industrial groups. As a first general pattern, it is observed that across all co-operative agreements firms tend to combine capabilities in technology and demand domains. Identifying that the drivers for co-operation bring together demand and technological capabilities indicates that firms tend to use co-operation as a means of coordinating various complementary and distributed stages of the innovation and production process. This finding suggests that one reason leading firms to co-operation is the combination of complementary capabilities. In this regard the findings seem to be reflecting the distributed innovation processes approach on the motives behind firms' desire to co-operate.

The finding also provides support for the proposition that firms are motivated to co-operation to link exploitation and exploration in complementary domains of knowledge. Although existing research has shown that exploration and exploitation are linked between inter- and intra-organizational levels spurring one another successively, in a recursive manner (Holmqvist, 2003; 2004), this paper suggests that a reason leading firms to co-operation is the

simultaneous attainment of these two search processes. Establishing such a relationship between exploration and exploitation in complementary domains of knowledge allows for the creation of interaction, feedback and mutual adjustments to occur between these domains of production which are important for the innovation process.

The findings can have implications for the interrelationships that can be created between dedicated biotechnology firms and established firms through co-operation. The most popular reason leading DBFs to co-operation suggests that they are seeking co-operation for the exploitation of their capabilities in biotechnologies, which witness diverse applications due to the nature of the technology, and that could arise by partnering with organizations capable to carry out downstream activities. Established firms are suggested to be willing to undertake downstream activities internally because it could offer a way for using further their likely underutilized capabilities in demand domains. Moreover, it is suggested that established firms aimed through co-operation to explore the potential of the new biotechnologies. DBFs would allow access to their competencies in biotechnologies in exchange for accessing demand capabilities that are required for the commercialization of their technological knowledge. The existence of a complementary relationship in the capabilities likely to be underutilized internally and of counterbalancing intentions for search on these domains could underlie a harmonious co-existence between these two industrial groups in the biotechnology sector. Existing theoretical arguments of the interrelationships between large and newly-established firms in high-technology industries (King *et al.*, 2003) and analysis of the evolution of the biotechnology sector (Nelson and Winter, 2002) have suggested the potential existence of such interrelationships between dedicated biotechnology firms and established firms.

7. Conclusions

This paper has sought to advance our existing understanding of the reasons behind firms' desires to co-operate: first, by combining two streams of literature within the knowledge-based view of the firm, that is, the distributed innovation processes approach and the dynamic capabilities perspective, which have not been synthesized before, and second, by offering a large-scale study of an internationally important, yet under-researched economic sector, the UK's biotechnology sector. The synthesis of the knowledge-access and knowledge-acquisition perspectives on the reasons behind firms' desires to co-operate has allowed this paper to examine more closely the interrelationships that may exist between these two types of motives. The paper has contended that firms' motives to co-operate are underpinned by a desire to combine distributed and complementary domains of knowledge and to link searches in exploration with exploitation that are present in these domains. The interrelationship between exploration and exploitation established in complementary domains of knowledge is important, because complementarity could ensure the matching of exploration with exploitation across firm boundaries. This has a number of implications. First, matching of these search processes across organizations could allow firms to make better use of their internal capabilities by linking them to opportunities created externally. In this way, internal search in exploration and exploitation could not only find alternatives to internal outlets, but could also be further reinforced due to the intertwined relationship that exists between these two search processes. Second, and as has been argued recently (Gupta *et al.*, 2006), complementarity in partners' domains of knowledge could allow for their specialization in either exploration or exploitation, a contention that remains to be examined. Third, the management of initiating co-operative agreements, in their nascent phases, could be coordinated by seeking for partners with search efforts that are counterbalancing those undertaken internally, and that are present within complementary domains of knowledge.

The findings of this paper also have implications for the type of interdependencies that can arise between firms that possess complementary capabilities and that focus on

counterbalancing types of search. Firms possessing capabilities in complementary domains of knowledge, and undertaking counterbalancing types of search within these domains, may share mutually compatible motives for co-operating. In situations where such conditions exist, then an interdependent relationship may arise between such types of firms, or institutions. With specific reference to the biotechnology sector, this paper has highlighted that this type of compatibility may exist in the motives for co-operation between established firms and new entrants. This is because newly established firms, as suggested by this paper's findings, co-operate mostly for the exploitation of technological capabilities and for the exploration of demand knowledge. This reason for co-operation seems to offer a mirror image for the most commonly cited reason for why established firms co-operate, namely the exploration of technological knowledge and the exploitation of demand knowledge. These types of firms, dedicated biotechnology firms and incumbents, it has been suggested, have mutually compatible reasons to co-operate and they may establish a symbiotic relationship through co-operation. It remains to be examined whether or not complementary capabilities will continue to be asymmetrically distributed, if they are and remain so, and if they can be readily accessed through co-operation and if mutually compatible motives for co-operation can be found, this could imply a perpetuation of a harmonious co-existence between new entrants and established firms, and of co-operative agreements as a means by which capabilities can be managed and production and innovation processes can be coordinated.

The findings of this study apply to the UK biotechnology sector and could form a stepping stone to examine whether similar findings can be identified in other sectors, time periods and countries. Similar analysis of other sectors and international comparisons among OECD member countries could, first, assist our understanding of the reasons that lead firms to co-operate, and second, indicate any general patterns across sectors and countries. This paper has concentrated on building a framework for understanding firm motives for co-operation when establishing co-operative agreements. Future research could concentrate on examining the

beneficial effects that the interplay between exploration and exploitation in complementary domains of knowledge in co-operative agreements may have on firm performance and their innovative capabilities. Finally, because of the focus of this paper, the organisational processes that firms use to interrelate and coordinate their capabilities and to manage their interactions with other organizations have been neglected. This type of organizational knowledge may warrant more attention due to the increasing use of co-operative agreements by firms. The use of in-depth case studies could shed more light on this issue, further informing managerial practice.

References

Acha, V. and Cusmano, L. (2005), 'Governance and Co-ordination of Distributed Innovation Processes: Patterns of R&D Co-operation in the Upstream Petroleum Industry', *Economics of Innovation and New Technology*, 14: 1-21.

Arora, A. and Gambardella, A. (1990), 'Complementarity and External Linkages: The Strategies of the Large Firms in Biotechnology', *Journal of Industrial Economics*, 38: 361-379.

Brusoni, S. and Prencipe, A. (2001), 'Managing knowledge in loosely Coupled Networks: Exploring the Links between Products and Knowledge Dynamics', *Journal of Management Studies*, 38: 1019-35.

Brusoni, S., Prencipe, A. and Pavitt, K. (2001), 'Knowledge Specialization, Organizational Coupling, and the Boundaries of the Firm: Why Do Firms Know More than They Make?', *Administrative Science Quarterly*, 46: 597-621.

Cattell, R. B. (1966), 'The Scree Test for the Number of Factors', *Multivariate Behavioural Research*, 1: 245-76.

Contractor, F. J., Kim, C. S. and Beldona, S. (2002), 'Interfirm Learning in Alliances and Technology Networks: An Empirical Study in the Global Pharmaceutical and Chemical Industry'. In F. J. Contractor and P. Lorange (eds) *Cooperative strategies and alliances*, London: Pergamon, pp. 493-516.

Contractor, F. J. and Lorange, P. (2002), 'The Growth of Alliances in the Knowledge-Based Economy'. In F. J. Contractor and P. Lorange (eds), *Cooperative strategies and alliances*, London: Pergamon, pp. 3-24.

Coombs, J. and Alston, Y. R. (2000), *Biotechnology Directory 2000*, Basingstoke: Macmillan.

Coombs, J. and Alston, Y. R. (2002), *Biotechnology Directory 2002*, Basingstoke: Macmillan.

Coombs, R., Harvey, M. and Tether, B. S. (2003), 'Analysing Distributed Processes of Provision and Innovation', *Industrial and Corporate Change*, 12: 1125-55.

Coombs, R. and Metcalfe, J. S. (2000), 'Organizing for Innovation: Co-ordinating Distributed Innovation Capabilities'. In J. N. Foss and V. Mahnke (eds) *Competence, Governance, and Entrepreneurship*, Oxford: Oxford University Press, pp. 209-31.

Coombs, R., Richards, A., Saviotti, P. P. and Walsh, V. (1996), 'Introduction: Technological Collaboration and Networks of Alliances in the Innovation Process'. In R. Coombs, A. Richards, P. P. Saviotti and V. Walsh (eds) *Technological Collaboration: The Dynamics of Cooperation in Industrial Innovation*, Cheltenham: Edward Elgar, pp. 1-18.

Coombs, R. and Tomlinson, M. (1998), 'Patterns in UK Company Innovation Styles: New Evidence from the CBI Innovation Trends Survey', *Technology Analysis & Strategic Management*, 10: 295-310.

Deeds, D. L. and Hill, C. W. L. (1996), 'Strategic Alliances and the Rate of New Product Development: An Empirical Study of Entrepreneurial Biotechnology Firms', *Journal of Business Venturing*, 11: 41-55.

Dosi, G., Nelson, R. R. and Winter, S. G. (2000), 'Introduction: The Nature and Dynamics of Organizational Capabilities'. In G. Dosi, R. R. Nelson and S. G. Winter (eds) *The Nature and Dynamics of Organizational Capabilities*, Oxford: Oxford University Press, pp. 21-4.

Dunteman, G. H. (1994), 'Principal Component Analysis'. In M. S. Lewis-Beck (eds) *Factor Analysis and Related Techniques*, London: Sage.

George, G., Zahra, S. A. and Wood, D. R. (2002), 'The Effects of Business-University Alliances on Innovative Output and Financial Performance: a Study of Publicly Traded Biotechnology Companies', *Journal of Business Venturing*, 17: 577-609.

Grant, R. M. (1996), 'Toward a Knowledge-Based Theory of the Firm', *Strategic Management Journal*, 17: 109-122.
Grant, R. M. and Baden-Fuller, C. (2004), 'A Knowledge Accessing Theory of Strategic Alliances', *Journal of Management Studies*, 41: 61-84.
Greis, N. P., Dibner, M. D. and Bean, A. S. (1995), 'External Partnering as a Response to Innovation Barriers and Global Competition in Biotechnology', *Research Policy*, 24: 609-30.
Gupta, A. K., Smith, K. G. and Shalley, C. E. (2006), 'The Interplay between Exploration and Exploitation', *Academy of Management Journal*, 49: 693-706.
Hagedoorn, J. (2002), 'Inter-firm R&D Partnerships: An Overview of Major Trends and Patterns since 1960', *Research Policy*, 31: 477-92.
Hagedoorn, J. and Roijakkers, N. (2006), 'Inter-firm R&D Partnering in Pharmaceutical Biotechnology since 1975: Trends, Patterns, and Networks', *Research Policy*, 35: 431-46.
Hagedoorn, J. and Schakenraad, J. (1994), 'The Effect of Strategic Technology Alliances on Company Performance', *Strategic Management Journal*, 15: 291-309.
Henderson, R. (1994), 'The Evolution of Integrative Capability: Innovation in Cardiovascular Drug Discovery', *Industrial and Corporate Change*, 3: 607-30.
Holmqvist, M. (2003), 'A Dynamic Model of Intra- and Interorganizational Learning', *Organization Studies*, 24: 95-123.
Holmqvist, M. (2004), 'Experiential Learning Processes of Exploitation and Exploration within and between Organizations: An Empirical Study of Product Development', *Organization Science*, 15: 70-81.
Inkpen, C. A. (2002), 'Learning, Knowledge Management, and Strategic Alliances: So Many Studies, so Many Unanswered Questions'. In F. J. Contractor, P. Lorange and P. N. Ghauri (eds) *Cooperative strategies and alliances*, London: Pergamon, pp. 267-90.
Jolliffe, I. T. (1972), 'Discarding Variables in a Principal Component Analysis I: Artificial Data', *Applied Statistics*, 22: 21-31.
Kaiser, H. F. (1960), 'The Application of Electronic Computers to Factor Analysis', *Educational and Psychological Measurement*, 20: 141-51.
Kaiser, H. F. (1970), 'A Second Generation Little Jiffy', *Psychometrika*, 35: 401-15.
Kaiser, H. F. (1974), 'An Index of Factorial Simplicity', *Psychometrika*, 39: 31-6.
Kenney, M. (1986) *Biotechnology: The University-Industrial Complex*, New Haven and London: Yale University Press.
King, D. R., Covin, J. G. and Hegarty, W. H. (2003), 'Complementary Resources and the Exploitation of Technological Innovations', *Journal of Management*, 29: 589-606.
Koza, P. M. and Lewin, A. Y. (1998), 'The Co-evolution of Strategic Alliances', *Organization Science*, 9: 255-64.
Lane, P. J. and Lubatkin, M. (1998), 'Relative Absorptive Capacity and Inter-Organizational Learning', *Strategic Management Journal*, 19: 461-77.
Lane, P. J., Salk, J. E. and Lyles, M. A. (2001), 'Absorptive Capacity, Learning, and Performance in International Joint Ventures', *Strategic Management Journal*, 22: 1139-61.
Lavie, D. and Rosenkopf, L. (2006), 'Balancing Exploration and Exploitation in Alliance Formation', *Academy of Management Journal*, 49: 797-818.
Lazaric, N. and Marengo, L. (2000), 'Towards a Characterization of Assets and Knowledge Created in Technological Agreements: Some Evidence from the Automobile Robotics Sector', *Industrial and Corporate Change*, 9: 53-86.
Levinthal, D. and March, J. G. (1993), 'The Myopia of Learning', *Strategic Management Journal*, 14: 95-112.

Malerba, F. and Orsenigo, L. (2000), 'Knowledge, Innovative Activities and Industrial Evolution', *Industrial and Corporate Change*, 9: 289-314.
March, J. G. (1991), 'Exploration and Exploitation in Organizational Learning', *Organization Science*, 2: 71-87.
Mowery, D. C., Oxley, J. E. and Silverman, B. S. (1996), 'Strategic Alliances and Interfirm Knowledge Transfer', *Strategic Management Journal*, 17: 77-91.
Mowery, D. C., Oxley, J. E. and Silverman, B. S. (2002), 'The Two Faces of Partner-Specific Absorptive Capacity: Learning and Co-specialization in Strategic Alliances'. In F. J. Contractor and P. Lorange (eds) *Cooperative Strategies and Alliances*, London: Pergamon.
Nelson, R. R. and Winter, S. G. (1977), 'In Search of Useful Theory of Innovation', *Research Policy*, 6: 36-76.
Nelson, R. R. and Winter, S. G. (1982), *An Evolutionary Theory of Economic Change*, Cambridge MA: Harvard University Press.
Nelson, R. R. and Winter, S. G. (2002), 'Evolutionary Theorizing in Economics', *Journal of Economic Perspectives*, 16: 23-46.
Nightingale, P. (2000), 'Economies of Scale in Experimentation: Knowledge and Technology in Pharmaceutical R&D', *Industrial and Corporate Change*, 9: 315-59.
OECD (1996), *Knowledge-Based Economy*, Paris: OECD.
OECD (2001), *Innovative Networks: Co-operation in National Innovation Systems*, Paris: OECD.
Orsenigo, L. (1989), *The Emergence of Biotechnology: Institutions and Markets in Industrial Innovation*, London: Pinter.
Pisano, G. (1990), 'The R&D Boundaries of the Firm: An Empirical Analysis', *Administrative Science Quarterly*, 35: 153-76.
Powell, W. W. (1996), 'Inter-organizational Collaboration in the Biotechnology Industry', *Journal of Institutional and Theoretical Economics*, 152: 197-215.
Powell, W. W., Koput, K. W. and Smith-Doerr, L. (1996), 'Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology', *Administrative Science Quarterly*, 41: 116-45.
Richardson, G. B. (1972), 'The Organization of Industry', *The Economic Journal*, 82: 883-96.
Rothaermel, F. T. (2001), 'Incumbent's Advantage through Exploiting Complementary Assets via Interfirm Cooperation', *Strategic Management Journal*, 22: 687-99.
Rothaermel, F. T. and Deeds, D. L. (2004), 'Exploration and Exploitation Alliances in Biotechnology: A System of New Product Development', *Strategic Management Journal*, 25: 201-21.
Rothwell, R. (1992), 'Successful Industrial Innovation: Critical Factors for the 1990s', *R & D Management*, 22: 221-39.
Saviotti, P. P. (1998), 'Industrial Structure and the Dynamics of Knowledge Generation in Biotechnology'. In J. Senker and R. van Vliet (eds) *Biotechnology and Competitive Advantage: Europe's Firms and the US Challenge*, Cheltenham: Edward Elgar.
Smith, H. L., Dickson, K. and Smith, S. L. (1991), ' "There are Two Sides to every Story": Innovation and Collaboration within Networks of Large and Small Firms', *Research Policy*, 20: 457-68.
Stevens, J. (1992), *Applied Multivariate Statistics for the Social Sciences*, New Jersey: Lawrence Erlbaum.
Teece, D. (1986), 'Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy', *Research Policy*, 15: 285-305.
Teece, D. and Pisano, G. (1994), 'The Dynamic Capabilities of Firms: An Introduction', *Industrial and Corporate Change*, 3: 537-56.

Teece, D. J., Pisano, G. and Shuen, A. (1997), 'Dynamic Capabilities and Strategic Management', *Strategic Management Journal*, 18: 509-33.
Valentin, F. and Jensen, R. L. (2003), 'Discontinuities and Distributed Innovation: The Case of Biotechnology in Food Processing ', *Industry and Innovation*, 10: 275-310.
Walsh, V. (1993), 'Stimulating Demand: Demand, Public Markets and Innovation in Biotechnology', *Science and Public Policy*, 20: 138-56.
Walsh, V. and Rodorfos, G. (2002), 'Technological and Organizational Innovation in Chemicals and Related Products', *Technology Analysis and Strategic Management*, 14: 273-98.
Winter, S. G. (2003), 'Understanding Dynamic Capabilities', *Strategic Management Journal*, 24: 991-95.
Zahra, S. A., Sapienza, H. J. and Davidson, P. (2006), 'Entrepreneurship and Dynamic Capabilities: A Review, Model and Research Agenda', *Journal of Management Studies*, 43: 917-55.
Zollo, M. and Winter, S. G. (2002), 'Deliberate Learning and the Evolution of Dynamic Capabilities', *Organization Science*, 13: 339-51.

Appendix: Correlation Matrices of the Original Constructs imported in the Principal Component Analysis

Table A.1 Correlation Matrix of Motives for Co-operation Dedicated Biotechnology Firms

		TEXPLR	TEXPLT	TEANDE	DEXPLR	DEXPLT	DEANDE
Correlation	TEXPLR	1					
	TEXPLT	0.327	1				
	TEANDE	0.255	0.385	1			
	MEXPLR	0.400	0.562	0.267	1		
	MEXPLT	0.456	0.199	0.168	0.058	1	
	MEANDE	0.262	0.328	0.297	0.233	0.202	1
Sig. (1-tailed)	TEXPLR		0.000	0.000	0.000	0.000	0.000
	TEXPLT	0.000		0.000	0.000	0.005	0.000
	TEANDE	0.000	0.000		0.000	0.015	0.000
	MEXPLR	0.000	0.000	0.000		0.229	0.001
	MEXPLT	0.000	0.005	0.015	0.229		0.004
	MEANDE	0.000	0.000	0.000	0.001	0.004	

Determinant: 0.295

Kaiser-Meyer-Olkin(KMO): 0.676

Bartlett's Test of Specification (BTS)Approximate Chi-Square: 200.61

DF: 15 Sig.: 0.000

Notes: Index of variables: TEXPLR stands for Technology Exploration, TEXPLT stands for Technology Exploitation, TEANDE stands for Technology Exploration & Exploitation, DEXPLR stands for Demand Exploration, DEXPLT stands for Demand Exploitation and DEANDE stands for Demand Exploration & Exploitation.

Table A.2 Correlation Matrix of Motives for Co-operation Pharmaceuticals & Chemicals Firms

		TEXPLR	TEXPLT	TEANDE	DEXPLR	DEXPLT	DEANDE
Correlation	TEXPLR	1					
	TEXPLT	0.334	1				
	TEANDE	0.587	0.308	1			
	DEXPLR	0.313	0.561	0.375	1		
	DEXPLT	0.751	0.285	0.605	0.105	1	
	DEANDE	0.565	0.357	0.652	0.253	0.442	1
Sig. (1-tailed)	TEXPLR		0.000	0.000	0.000	0.000	0.000
	TEXPLT	0.000		0.000	0.000	0.000	0.000
	TEANDE	0.000	0.000		0.000	0.000	0.000
	DEXPLR	0.000	0.000	0.000		0.065	0.000
	DEXPLT	0.000	0.000	0.000	0.065		0.000
	DEANDE	0.000	0.000	0.000	0.000	0.000	

Determinant: 6.023E-02

Kaiser-Meyer-Olkin (KMO): 0.635

Bartlett's Test of Specification (BTS) Approximate Chi-Square: 579.23

DF: 15 Sig.: 0.000

Notes: Index of variables: TEXPLR stands for Technology Exploration, TEXPLT stands for Technology Exploitation, TEANDE stands for Technology Exploration & Exploitation, DEXPLR stands for Demand Exploration, DEXPLT stands for Demand Exploitation and DEANDE stands for Demand Exploration & Exploitation.

Table A.3 Correlation Matrix of Motives for Co-operation Firms in Other Industries

		TEXPLR	TEXPLT	TEANDE	DEXPLR	DEXPLT	DEANDE
Correlation	TEXPLR	1					
	TEXPLT	0.094	1				
	TEANDE	0.194	0.223	1			
	DEXPLR	0.383	0.367	0.456	1		
	DEXPLT	0.338	0.156	0.516	0.354	1	
	DEANDE	0.287	0.007	0.148	-0.048	0.155	1
Sig. (1-tailed)	TEXPLR		0.135	0.011	0.000	0.000	0.000
	TEXPLT	0.135		0.004	0.000	0.033	0.468
	TEANDE	0.011	0.004		0.000	0.000	0.041
	DEXPLR	0.000	0.000	0.000		0.000	0.287
	DEXPLT	0.000	0.033	0.000	0.000		0.034
	DEANDE	0.000	0.468	0.041	0.287	0.034	

Determinant: 0.333

Kaiser-Meyer-Olkin(KMO): 0.614

Bartlett's Test of Specification (BTS) Approximate Chi-Square: 149.908

DF: 15 Sig.: 0.000

Notes: Index of variables: TEXPLR stands for Technology Exploration, TEXPLT stands for Technology Exploitation, TEANDE stands for Technology Exploration & Exploitation, DEXPLR stands for Demand Exploration, DEXPLT stands for Demand Exploitation and DEANDE stands for Demand Exploration & Exploitation.