HOW AMBIDEXTROUS ARE FIRMS ACTUALLY? SEARCHING FOR THE R&D CAPABILITY FRONTIER OF EXPLORATION AND EXPLOITATION USING DATA ENVELOPMENT ANALYSIS

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ABSTRACT

The study of ambidexterity has been attracting research attention since March's (1991) seminal work on exploration and exploitation. The possible reason behind this is that successful organisations should be able to handle both radical and incremental innovation well. Such organisations have often been categorised as ambidexterity. After reviewing the literature, this paper propose that there is still confusion around conceptualising the key concepts and previous studies did not provide adequate ways to identify ambidextrous organisations. To fill theses gaps, this study will take exploration and exploitation as R&D capabilities and aim to identify ambidexterity on a capability based approach. To achieve that this paper takes an alternative approach by applying data envelopment analysis as its method of measuring innovation capabilities, using data sets of companies within the same sectors to calculate possible capability frontier. The results suggest that the organisation that are on the capability frontier can be considered as ambidexterity within each of the three selected sectors. Moreover, the results provide a benchmark set for each organisation that are not on the frontier to move towards this frontier. Based on the results, this paper proposes that organisations with high R&D expenditure or large number of patents are not necessarily be ambidextrous; rather, it is how effective certain innovation input is transferred to output that defines ambidextrous organisations. This has provided a way of benchmarking for managers. Future studies could build on and expend the research framework proposed by this research to get more comprehensive results.

KEY WORDS: Exploration, Exploitation, Innovation Capability, Ambidexterity, Data Envelopment Analysis

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INTRODUCTION

Background

The term ambidexterity is originally used to describe people who is equally adapted in using both the left and right hand (Maier, 2015, p. 1). Linking this definition with how organisations could survive in the increasingly intensively competition, Duncan (1976) made the first attempt to introduce the concept of 'ambidextrous organisations' into management studies. In his initial propose it is argued that organisations have to design a dual structure that can shift based on different circumstance to support the innovation, organisations that is able to support this dual structure shifting can be identified as ambidexterity. Not until March's (1991) influential contribution on exploration and exploitation, did the investigation into ambidexterity start to attract attention from management scholars. In this regard, ambidexterity is conceptualised and directly linked to the management of exploration and exploitation by scholars. Consequently, it is believed by many that organisations can achieve ambidexterity by managing the tension between exploration and exploitation appropriately.

Following March's thoughts, studies into ambidexterity have mainly focused on the two aspects. First, how organisations can achieve ambidexterity. Different approaches have been proposed and yet it is argued that how to achieve ambidexterity will be influenced by the difference of competitive markets and external environment (O'Reilly and Tushman, 2013, p. 14). These different approaches of achieving ambidexterity will be discussed in more detail in the literature review section. Second, the relationship between ambidexterity and organisational performance. In this regards, although there are studies reporting ambidexterity have no relationship with organisational performance (e.g. Ebben and Johnson, 2005), most studies have lent support to the point that achieving ambidexterity would lead to better organisational performance (e.g. He and Wong, 2004; Jansen et al., 2006; Lin et al., 2013). Overall, current studies into ambidexterity have provided some insight on how to manage exploration and exploitation to achieve better organisational performance.

Research Objective

However, there is still confusion around conceptualising the key concepts, especially regarding the interpretation between exploration and exploitation, and radical and incremental innovation. Also, it is argued by this paper that previous studies did not provide adequate ways to identify ambidextrous organisations. As a result, there are still gaps to be addressed in terms of conceptualisation and identification of ambidexterity. To fill theses gaps, this study aims to investigate ambidexterity from a capability based approach. Furthermore, this study proposes that it may be beneficial to identify ambidextrous organisations within certain context; to do so, sectors are introduced as the context and organisations are compared within each sector.

Structure

The remaining parts of this paper will be structured as follows. First, relevant discussion on exploration, exploitation and ambidexterity will be presented. This will include how has these concepts been studied and whether it is helpful to study these concepts from the perspective of innovation capability. Second, based on the research framework, method used in this study will be discussed. The results and discussion of findings will be the following part. This paper will end with concluding remarks including implication for practice and agenda for future research.

LITERATURE REVIEW

From Exploration vs Exploitation towards Ambidexterity

Ever since March's (1991) seminal work in organisational learning, the conceptual distinction between exploration and exploitation has gained much academic attention. According to his conceptualisation, exploration is defined by terms such as 'search, variation, risk taking, experimentation, play, flexibility, discovery and innovation', whereas exploitation is described by terms such as 'refinement, choice, production, efficiency, selection, implementation and execution' (ibid, p. 71). Building on this, there is a further argument that both concepts are essential in management practices but will inevitably compete for the resources available to an organisation. Besides the application of these concepts in organisational learning, studies have also used and apply this thinking in innovation management. Following the original view that exploration and exploitation will compete for resources, studies have focused on resource allocation and proposing a 'trade-off' perspective (e.g. Chang and Hughes 2012, p. 2; Schulze, 2009, p. 28). This is been regarded as a 'either or' way of thinking, which means that increasing the level of one might reduce level of the other. However, this 'trade-off' way of thinking have been questioned. For example, Gupta *et al.* (2006, pp. 695-696) challenged the assumption that exploration and exploitation will compete for scarce organisational resources by re-examining the nature of such resources. They further questioned whether exploration and exploitation are diametrically opposed as two ends of a continuum or orthogonal to each other. Consequently, more studies have argued that there is a way that exploration and exploitation can exist together and there should be a 'both and' way of thinking (e.g. Andriopoulos and Lewis, 2009, p. 709; Papachroni *et al.*, 2015, p. 88).

Searching for a new way to manage exploration and exploitation, studies have introduced the idea of ambidexterity, which refers to organisations that is able to do two things at the same time well. Combining the idea of ambidexterity with exploration and exploitation, Tushman and O'Reilly (1996) proposed that exploration and exploitation can happen simultaneously, and organisations that can achieve this is ambidextrous organisations. This view has inspired a large number of studies to investigate into under what condition become ambidexterity is useful, and the relationship between ambidexterity and organisational performance and survival (O'Reilly and Tushman, 2013). In addition, studies are keen to know how an organisations can achieve ambidexterity. However, based on different perspectives on exploration and exploitation, there is still not an agreed way of how ambidexterity should be achieved.

Referring to the original principles from Duncan (1976), temporal ambidexterity is proposed. studies with the temporal ambidexterity perspective emphasises how an organisation can or ought to shift from exploration to exploitation, or the other way around; the reason behind the shifting is often dependant on external environment and economic cycles (e.g. Gilsing and Nooteboom, 2006; Mudambi and Swift, 2011). Besides, studies that considered that exploration and exploitation do need support from different organisational structures but this should exists simultaneously have pointed out the structure ambidexterity approach. The structural ambidexterity perspective argues that the tension between exploration and exploitation is significant, organisations can create different organisational units with unique architectural and cultural design that enable either of the two activities so that having different exploration-focused and exploitation-focused units enables organisations to find a balance (e.g. Smith and Tushman, 2005, p. 524; Tushman and O'Reilly, 1996, p. 25). On the contrast,

considering there should be more interaction between exploration and exploitation and that they are not mutually exclusive of one and another, studies argued for contextual ambidexterity. Studies taking this perspective have indicated that organisations can create certain contexts that allow both exploration and exploitation to co-exist (Gibson and Birkinshaw, 2004). These contexts may include multiple aspects, such as culture (e.g. Wang and Rafiq, 2012), leadership (e.g. Lin and McDonough, 2011) and cognitive style of top managers (e.g. Karhu *et al.*, 2016). Arguably, these approaches proposed to achieve ambidexterity might serve its usefulness under certain circumstance (O'Reilly and Tushman, 2013). However, the question still remains that how organisation can understand whether they are ambidextrous or not.

This brings up the issues of measuring ambidexterity. In previous quantitative studies, ambidexterity is often measured as organisations that are able to generate knowledge from learning process that enables both incremental and radical innovation. Whereas in previous qualitative studies, ambidextrous is referred to companies that have reputation of being innovative and also maintaining a good finical performance. Table 1 provides examples of how previous empirical studies have measured or identified ambidexterity.

Table 1 Examples of Identifying Ambidexterity

Study	Research Method	Perspective Taken	Ambidexterity
Knight and Harvey, 2015	Case Studies, qualitative	Contextual ambidexterity	Case was selected because it: 1) is a leading company within the context and 2) has an explicit mandate for change.
Cantarello et al., 2012	Case Studies, qualitative	Multi-level ambidexterity, in line with contextual ambidexterity	Case companies: 1) are not only technology but also custom knowledge is important, 2) are highly and consistently profitable and simultaneously receiving awards and top ranking for cutting edge innovation, 3) have developed and managed ambidexterity capability in the search phase of the innovation process.
He and Wong, 2004	Survey, quantitative	Didn't specify	• Ambidexterity: 1) have both high score in exploration and exploitation, 2) have relatively equal emphasis on both exploration and exploitation. • Exploration: 1) Introduce new generation of products, 2) Extend product range, 3) Open up new markets, 4) Enter new technology fields • Exploitation: 1) Improve existing product quality, 2) Improve production flexibility, 3) Reduce production cost, 4) Improve yield or reduce material consumption

Jansen et al., 2005	Survey, quantitative	Contextual ambidexterity	• Ambidexterity: Exploration × Exploitation • Sample items for exploration: 1) we experiment with new products and service in our local market, 2) we commercialise products and services that are completely new to our market • Sample items for exploitation: 1) we frequently refine the provision of existing products and services, 2) we regularly implement small adaptations to existing products and services

It is notable that the common ways of measuring and identifying ambidexterity in previous studies are outcome based. This is reasonable because without looking into the organisational processes, studies tend to define exploration and exploitation on outcomes of certain activities. Hence, if ambidexterity is conceptualised by exploration and exploitation, the measurement of ambidextrous organisation will likely be outcome based. However, this study argues that outcome based identification of ambidexterity has the following limitations. First, outcome based measure will likely to neglect the impact of input scale and size. It has long been proven in studies that organisational size will have influence on organisational innovation (e.g. Damanpour, 1992 and Mote et al., 2016), ignoring the input aspect may cause inaccurate results. Second, considering the possible impact of size and scale, the results of outcome based measure does not provide good evidence for benchmarking organisations. Last, it is still in doubt that whether certain outcome is actually the output of exploration and exploitation. This is to say the organisational processes of exploration and exploitation is rather in a 'black box'. Hence, the outcome measurement chosen may not correctly reflect exploration and exploitation. As a result, it may worth considering to measure and identify ambidexterity on a capability based approach.

Innovation Capability

To further understand if a capability based approach measure is beneficial and how could it be used to identify ambidexterity, this study took a closer look at innovation capability. Despite the fact that innovation capability is attracting research interest in recent years, there is still lack of consensus in defining the concept (Iddris, 2016, p. 246; Zawislak et al., 2012, p. 17). The common understanding in this field of studies is that innovation capability does not stand on its own, instead, it is a combination of different organisational factors and capabilities (e.g. Slater et al., 2014, p. 554 about product innovation capability; Frishammar et al., 2012, p. 522 about process innovation capability). Generally, one approach to define innovation capability is based on innovation processes. Taking product innovation as an example, product innovation capabilities refers to firms' ability to generate and support innovation from idea generation to the commercialisation of the end products (Assink, 2006, p. 219; Lawson and Samson, 2001, p. 384). Under this approach, innovation capability may include but research (technology) and development capability, operations capability, management capability and transaction capability (Zawislak et al., 2012, p. 17). Another approach of

conceptualising innovation capability is through organisational factors that enables innovation, this may include knowledge management, organisational culture and leadership (Iddris, 2016, p. 246; Saunila and Ukko, 2013, p. 993). Nevertheless, these two approaches are still similarly building around the understanding that capability refers to organisations' ability to accomplish certain outcomes.

This has led to the discussion on clarifying the relationship between some similar terminology of capability, productivity and efficiency. Starting by looking at the conceptualisation of productivity, which shows many common features with the definition of capability, productivity can simply mean how well and how much companies produce from resources used (Tangen, 2005, p. 36). Comparing to the conceptualisation of capability, it is notable that realising productivity in organisations is similar to gaining certain organisational capability. Moreover, Tangen (2005, p. 37) further summarised the conceptualisation of productivity from three aspects, 1) relationship between rations of output to the input used, 2) relationship between actual and potential output, and 3) efficiency of resource allocation. In this conceptualisation, two of the three aspects involve the thinking of efficiency. By definition (Charnes et al., 1978, p. 431), efficiency refers to maximum amount of output obtained from given amount of input level (linked to the first aspect of productivity) or certain amount of output generated by the minimum amount of input (linked to the third aspect of productivity). The link between productivity and efficiency is also support by Koss and Lewis (1993, p. 282), they have argued that efficiency can be an important part in measuring productivity if efficiency is a priority in defining productivity. As a result, this study will use the following logic, organisations that have capabilities must be able to achieve high productivity, meaning that they are efficient in certain activities or processes.

Considering the fact that innovation capability is consist of different other factors, studies usually use combinations of measurements that covers different aspects to measure the overall innovation capability. These aspects include R&D, decision making, marketing, manufacturing and capital; within each aspect, there are specific items used for measures (Wang et al., 2008, p. 352). In survey based studies, these aspects are often measured based on the actions or activities that managers took, which is mostly captured by questionnaires. Taking the scale from Yam et al. (2004) for R&D capability as an example, their measurements includes elements such as mechanisms to encourage and reward inventiveness and creativity, and relevance of R&D plan to the corporate.

Another option that may be suitable is through measuring innovation efficiency. As discussed previously, organisations that have innovation capability is likely to be efficient at innovation process. Also, comparing the measurements from innovation capability and innovation efficiency, it is notable that both measurements shows overlapping in items such as sales, total income and patents, to name but a few (see for example Cruz-Cázares et al., 2013 for innovation efficiency measurements). Hence, this paper proposes that it is applicable to use approaches of analysing innovation efficiency to measure innovation capability, especially in R&D capability.

Exploration and Exploitation as R&D Capability

In the initial settings, exploration and exploitation is conceptualised as activities (see for example March, 1991). Following his view, some studies have applied this conceptualisation and define them as activities. For example, Blindenbach-Driessen and Ende (2014, p. 1090) have defined exploration as developing new products or services,

whereas exploitation refers to improving existing operational processes in the firm; their definition includes the distinction of product and process innovation, which is different but has similar features to the definition of March (1991). In contrast, there are also some studies define exploration and exploitation as capabilities. For example, Quintana-Garcia & Benavides-Velasso (2008, P. 495) conceptualised exploration as firm's ability to do 'distance search' and generate radical products whereas exploitation is firm's ability to do 'local search' and generate incremental products. This has also been supported by Iddris (2016, p. 253), claiming that exploration and exploitation can be a useful framework to study innovation capability.

Nevertheless, this study argues that whether to consider exploration and exploitation as capability is related to their relationship with radical and incremental innovation. Taking exploration and exploitation as organisational activities, studies have stated that exploration activities that will lead to radical innovation, whereas exploitation will lead to incremental innovation (e.g. de Visser and Faems, 2015, p. 362). However, Atuahene-Gima (2005, p. 62) further argues that exploitation will also contribute to radical innovation and exploration to incremental innovation. Stepping back from the processes of innovation within the organisations, exploration and exploitation can be also considered as the ability of an organisation to achieve radical or incremental innovation as outcomes (Lin et al., 2013). This is beneficial because it is still unclear how exploration and exploitation is reflected in managerial practices within an organisation.

It has also been proposed that exploration and exploitation can have affect in different stages of innovation, such as marketing (e.g. Kyriakopoulos and Moorman, 2004), strategic management (e.g. Ireland and Webb, 2009) and human resource management (e.g. Litrico and Lee, 2008). However, considering the original conceptualisation from organisational learning, this paper will investigate exploration and exploitation as capability in the R&D stage, i.e. conceptualising it as R&D capability. The reason is that first, the conceptualisation of exploration and exploitation is clearer in the R&D phase. Second, input and output of the R&D phase is relatively tangible and clear, it will benefit this study by using it to test the capability based approach.

To sum up, this study will define ambidexterity in a capability based approach as organisations that 1) have both exploration and exploitation and 2) able to maintain efficiency in both exploration and exploitation. Exploration and exploitation is conceptualised as organisations' R&D capability, specifically, exploration means the ability of generating R&D outcome that is new to the organisation and exploitation means the ability of generating R&D outcome that is based on existing knowledge of the organisation. Hence, the measurement for it will be exploration is measured by the number of patents that have no self-citation and exploitation is the number of patents that have self-citation. Ambidexterity is measured by how efficient the R&D input in transformed into these two R&D outputs. Overall, figure 1 show the overall research framework for this study.

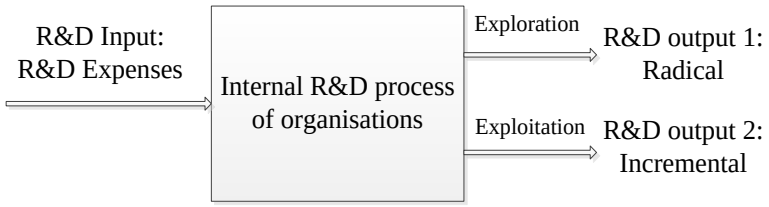

Figure 1 Research Framewaork

METHODOLOGY

Overview of selected method

To fill the gap of the current understanding of ambidexterity, this study have chosen the data envelopment analysis (DEA) as the method of analysis. DEA is a mathematic modelling method that focus on the performance of certain sets of entities (in this case they are been called decision making units) with multiple inputs and outputs (Charnes et al., 1994, p. 4; Cooper et al. 2007, p. 1). Since it was first introduced, DEA has been regarded as an excellent alternative of measuring and evaluating performance of decision making units DMUs; it has also been regarded to provide more insight than other methods in conditions that the relationship between multiple inputs and outputs are complex and unclear (Cooper et al. 2011, p. 2).

DEA is often used for analysis of the 'efficiency score' among a certain sets of DMUs. In some case, this method can be used to identifying the 'best-practice' or benchmarking a set of organisations (e.g. Guan et al., 2006 and Zhu, 2015). This feature has made DEA a good fit of the purpose of this research that using a capability based approach of identifying ambidexterity. When considering exploration and exploitation as capabilities, the efficient DMUs can be defined as 'most capable' or have 'greatest capability' within the selected context. The logic behind DEA fits the general definition of ambidexterity, which refers to the organisations that 1) have both exploration and exploitation and 2) manage to do both well. Similarly, the efficient DMUs identified by DEA are the ones that can best turn innovation input into either radical or incremental innovation. Hence, DEA provides an analysis on how well organisations do exploration and exploitation. Consequently, DEA may be useful to identify which organisation is ambidextrous within the selected context.

Selecting DEA Model

The application of DEA can be found in numerous contexts, such as hospital, education, manufacturing and finical service. However, it is notable that despite the development of alternative models based on the selected context, the overall idea of DEA can be categorised as five different types of basic models. Table 2 presented these basic models and made a comparison among some key features.

Table 2 Comparison of basic DEA models

DEA Models	Returns to Scale	Orientation
CCR Output	Constant	Output
CCR Input	Constant	Input
BCC Output	Variable	Output
BCC Input	Variable	Input
Additive	Variable	Input and Output

Considering the nature of innovation activities, the outcome of innovation is often unpredictable. Hence, it seems reasonable to choose an input oriented model. However, considering the original level of inputs may vary among the sample organisations, simply use input orientated model will cause suggested improvement unrealistic. Hence, an analysis based on output oriented model is also included. In terms of return to scale, the success of R&D is relevant to the size of the company. Therefore, return to scale in

this study is considered to be variant rather than constant. As a result, this study will analyse data based on the BCC model, both input and output oriented.

Measurements of input and output of innovation

This study has relied on secondary data. This is because this study takes exploration and exploitation as R&D capability. Although secondary data may be incorrect in measuring innovation output, in measuring R&D output it can provide a relative accurate and objective results. The use of public available data to measure innovation became popular since 1980s, and in the early stage, the focuses are pretty much on innovation inputs (Bain and Kleinknecht, 2016, p. 1). After realising the limitation of the lack of measurements on the 'output' side, indicators have been developed to capture innovation based on its outcomes.

On the input side, the input of innovation refers to the resource organisations put into different stages of innovation processes (Adams et al., 2006, p. 27). Accordingly, there will be two things to be specified, resources and stages of innovation. Resources may include people, physical and financial resource, idea and tools, whereas stages contain activities from idea generation, R&D, testing to commercialisation (Hagedoorn and Cloodt, 2003, p. 1368). Studies using the 'input data' to measure innovation often focus on financial resource allocated to R&D, i.e. R&D expenditures or R&D expense (Flor and Oltra, 2004, p. 324). In addition to that, Flor and Oltra (2004, p. 325) also pointed out other indicators such as existence of formalised R&D department, participation in external R&D projects, acceptance on publicly-funded innovation programs and educational background of staff that can be used as input indicator for innovation. However, in terms of this study, formalised R&D department can only be quantified as zero (no)/ one (yes) variable, and other indicators are difficult to quantify. As a result, this study will use a single indicator of R&D expenditures for the input data.

From the output side, since the late 1950s, the number of patens became a primary indicator of the innovation outputs (Santarelli and Piergiovanni, 1996, p. 689). Through the development of measuring innovation, it was noted that using paten counts to indicate innovation is rather indirect and with few limitations (Coombs et al., 1996, p. 404). To address this, studies have put effort into developing additional indicators based on patens and also finding alternative indicators to supplement data from paten. As a result, there are now two streams of indicators available to measure the 'output' side of innovation, namely paten data and literature-based innovation output. According to the review of Becheikh et al. (2006), 18% of the studies from 1993 to 2003 used patens as measurement of innovation while 25% used literature-based indicators; it is also notable that there are also 15% of the studies have combined different types of measures. Considering the complexity of defining exploration and exploitation in this part of the study, it may be wise to use a combination of both paten and literature-based data on the 'output' side. This study will mainly use R&D expense as input data and patents as output data. Exploration and exploitation will be measured based on self-citation.

Sampling and Data collection

Data was collected from three sectors, coded as: Sector B, manufacture of electronic and electrical equipment, Sector C, manufacture of transportation equipment, and Sector D, manufacture of machinery and equipment.

The collection of input data is rely on two databases, Amadeus and Fame. In total, these two databases provide basic information of the list of companies, including location,

website, registration number, operating revenue, number of employee; and also input data of R&D expense. The data of R&D expense is collected according the absolute year of 2014, 2015 and 2016. This study will rely on the data from 2014, and use data from 2015 and 2016 as reference for each companies. The process of company selection is presented in table 3 with manufacture of electronic and electrical equipment as an example.

Table 3 Example of Search Strategy

Search Steps		Step result	Search result
1.	All active companies and companies with unknown situation	3,209,932	3,209,932
2.	Region/Country/region in country: United Kingdom	239,589	226,197
3.	NACE Rev. 2 (Primary codes only): 26 - Manufacture of computer, electronic and optical products, 27 - Manufacture of electrical equipment	33,112	2,156
Filters based on data availability			
4.	Companies that have reported data of Research and Development Expenses (2014)	2,156	300
5	Companies that have both patents with self-citation and patents without self-citation	300	63

After the initial selection of the companies, results from two databases were compared, companies that are only shown in one databases were added in the main data sets and companies with conflict data recorded in the two database were marked out. For the companies that have different data recorded in the two databases, additional search is conducted; this includes checking in the annual reports (if available) and other official source. If the conflict of data reported is still unsolved, this study select to go alone with the Fame database because it is a specialised database in the UK context.

Patent data was first collected from the Amadeus database, with basic information of each patent included. After this, each patent is searched on ‘Patents Publication Enquiry’ from the Intellectual Property Office website for detailed information with its publication number. Furthermore, each patent is classified as ‘radical’ or ‘incremental’ according to a certain code developed from previous studies. Companies whose patent may not reported in the Amadeus database is been searched in the ‘Espacenet’ database with the company name as ‘applicant’. After these searches and classifications, companies that are still missing output data is been marked out. Backwards and forwards citation is recorded. Patents that have self-citation is categorised under exploitation and patents that doesn’t have self-citation is categorised under exploration.

The final sample size of this study consist of 112 companies and 1,361 patents. Further details of data is shown in Table 4, descriptive statics.

Table 4 Descriptive Statistics

Item	Total (Count)	Mean	SD
Sector B (N=63)			
R&D_E	269,298	4,274.571	11469.48
Exploration	346	5	6.753429274
Exploitation	290	5	9.029592358
Sector C (N=13)			
R&D_E	1,759,408	135,339.077	378100.9372
Exploration	209	16	19.18533
Exploitation	114	9	13.49169
Sector D (N=36)			
R&D_E	166,582	4,627.278	10902.8825
Exploration	227	6	7.992209
Exploitation	175	3	5.596697
Total (N=112)			
R&D_E	2,195,288	19600.79	131685.2
Exploration	782	6.982143	9.823654
Exploitation	579	5.169643	8.765091

RESULTS

The analysis is based on MaxDEA software. The software is used to run the DEA model in this study, to get results on scores, benchmarks and projection for each DMU in this study. Table 5 provided an overview of results for the 112 sample companies in this study. The table has provided the following information: 1) two sets of efficiency score based on both input (column 2) and output (column 5) orientated model, 2) two sets of benchmarks based on both input (column 3) and output (colum 6) orientated model, 3) a projection value of R&D expense based on input orientated model (column 4) and 4) projection values for both innovation output based on output orientated model (column 7 & 8). The projection value is an indication of the target value that each DMU has to achieve in order to become efficient.

Table 5 Results from Data Analysis

DMU	Score (Input)	Benchmark (Lambda)	Projection (R&D_E)	Score (output)	Benchmark (Lambda)	Projection (exploration)	Projection (exploitation)
Sector B							
B1	0.000986	B57(0.400000); B63(0.600000)	83.6	0.087719	B5(1.000000)	24	57
B2	1	B2(1.000000)	36306	1	B2(1.000000)	33	42
B3	0.001288	B63(1.000000)	16	0.092922	B19(0.714923); B2(0.285077)	32.285077	14.118011
B4	0.002308	B62(0.250000); B63(0.750000)	26.25	0.124017	B19(0.746229); B2(0.253771)	32.253771	12.897073
B5	1	B5(1.000000)	10521	1	B5(1.000000)	24	57
B6	0.383311	B19(0.365672); B5(0.194030); B57(0.440299)	3181.097015	0.652734	B19(0.551849); B2(0.077058); B5(0.371093)	29.108317	26.044284
B7	0.002474	B63(1.000000)	16	0.095239	B19(0.836079); B2(0.090121); B5(0.073800)	31.499724	10.499908
B8	0.244858	B19(0.274627); B5(0.047761); B57(0.677612)	1422.623881	0.481332	B19(0.631233); B2(0.004011); B5(0.364756)	29.08596	22.853255

B9	0.010556	B62(1.000000)	57	0.218238	B19(0.924997); B2(0.075003)	32.075003	5.925117
B10	0.1205	B19(0.166667); B57(0.166667); B62(0.666667)	551.166667	0.350393	B19(0.888099); B2(0.032055); B5(0.079846)	31.393289	8.561806
B11	0.010974	B62(0.750000); B63(0.250000)	46.75	0.188036	B19(0.946732); B2(0.037220); B5(0.016047)	31.908843	5.318141
B12	0.526918	B5(0.195652); B57(0.804348)	2207.26087	0.693971	B5(0.387384); B57(0.612616)	12.97291	28.819659
B13	0.00402	B63(1.000000)	16	0.072533	B19(0.703154); B5(0.182871); B57(0.113975)	27.573682	13.786841
B14	0.018334	B57(0.300000); B63(0.700000)	66.7	0.181146	B19(0.213691); B5(0.278068); B57(0.508241)	16.561196	22.081595
B15	0.007574	B62(0.250000); B63(0.750000)	26.25	0.13017	B19(0.893471); B5(0.083261); B57(0.023268)	30.728953	7.682238
B16	0.010291	B57(0.100000); B63(0.900000)	32.9	0.13791	B19(0.493740); B5(0.162002); B57(0.344257)	21.75329	14.502193
B17	0.024668	B57(0.300000); B62(0.275000); B63(0.425000)	77.975	0.250466	B19(0.412556); B5(0.179797); B57(0.407647)	19.9628	15.97024
B18	0.013292	B57(0.100000); B62(0.175000); B63(0.725000)	40.075	0.170226	B19(0.590622); B5(0.119002); B57(0.290376)	23.498218	11.749109
B19	1	B19(1.000000)	2894	1	B19(1.000000)	32	3
B20	0.0057	B63(1.000000)	16	0.088418	B19(0.566367); B5(0.105235); B57(0.328398)	22.619776	11.309888
B21	0.204819	B19(0.166667); B57(0.166667); B62(0.666667)	551.166667	0.418745	B19(0.747326); B5(0.046584); B57(0.206090)	26.268985	7.164269
B22	0.014914	B57(0.100000); B62(0.175000); B63(0.725000)	40.075	0.180889	B19(0.552373); B5(0.097293); B57(0.350334)	22.112982	11.056491
B23	0.012467	B57(0.100000); B63(0.900000)	32.9	0.122924	B19(0.281766); B5(0.163573); B57(0.554660)	16.270247	16.270247
B24	0.00607	B63(1.000000)	16	0.121171	B19(0.680848); B5(0.058687); B57(0.260466)	24.758395	8.252798
B25	0.006342	B63(1.000000)	16	0.123871	B19(0.664741); B5(0.051975); B57(0.283284)	24.218817	8.072939
B26	0.026437	B57(0.300000); B63(0.700000)	66.7	0.186871	B5(0.226200); B57(0.773800)	10.071594	21.405186
B27	0.058259	B19(0.011905); B57(0.297619); B62(0.690476)	128.869048	0.365379	B19(0.452404); B5(0.077538); B57(0.470058)	19.158194	10.947539
B28	0.035462	B57(0.200000); B62(0.600000); B63(0.200000)	74.4	0.305725	B19(0.483688); B5(0.058310); B57(0.458002)	19.625471	9.812735
B29	0.015833	B57(0.100000); B63(0.900000)	32.9	0.171263	B19(0.386251); B5(0.081912); B57(0.531837)	17.516945	11.677963
B30	0.036309	B57(0.300000); B63(0.700000)	66.7	0.217958	B5(0.159830); B57(0.840170)	8.876935	18.352167
B31	0.019855	B57(0.100000); B63(0.900000)	32.9	0.188405	B19(0.345810); B5(0.051780); B57(0.602410)	15.92311	10.615407
B32	0.032906	B57(0.200000); B62(0.100000); B63(0.700000)	53.9	0.265416	B19(0.307311); B5(0.060032); B57(0.632657)	15.070668	11.303001
B33	0.043032	B57(0.300000); B63(0.700000)	66.7	0.23568	B19(0.005120); B5(0.130721); B57(0.864159)	8.486097	16.972193
B34	0.629791	B19(0.320000); B62(0.680000)	964.84	0.750079	B19(0.519915); B62(0.480085)	19.997885	2.039831

B35	0.080301	B57(0.600000); B63(0.400000)	117.4	0.419583	B5(0.123549); B57(0.876451)	8.223878	16.683243
B36	0.606134	B19(0.257937); B57(0.448413); B62(0.293651)	846.162698	0.759472	B19(0.423273); B5(0.006226); B57(0.570501)	17.117159	7.900227
B37	0.024015	B57(0.100000); B63(0.900000)	32.9	0.162728	B19(0.198607); B5(0.062594); B57(0.738799)	12.290477	12.290477
B38	0.077895	B57(0.500000); B62(0.125000); B63(0.375000)	105.625	0.450316	B19(0.143971); B5(0.075560); B57(0.780470)	11.10331	13.323973
B39	0.037871	B57(0.200000); B63(0.800000)	49.8	0.18716	B5(0.109327); B57(0.890673)	7.967879	16.029025
B40	0.012569	B63(1.000000)	16	0.123906	B19(0.387483); B5(0.003706); B57(0.608811)	16.141266	8.070633
B41	0.633628	B19(0.246032); B57(0.150794); B62(0.603175)	774.293651	0.772726	B19(0.401261); B57(0.207983); B62(0.390755)	16.823547	3.882357
B42	0.043646	B57(0.200000); B63(0.800000)	49.8	0.196661	B5(0.092492); B57(0.907508)	7.664861	15.254644
B43	0.047977	B57(0.200000); B63(0.800000)	49.8	0.266684	B19(0.176851); B5(0.036176); B57(0.786974)	11.249277	11.249277
B44	0.01768	B63(1.000000)	16	0.092318	B19(0.168135); B5(0.025592); B57(0.806273)	10.832169	10.832169
B45	0.045748	B57(0.100000); B62(0.175000); B63(0.725000)	40.075	0.304308	B19(0.265944); B57(0.504039); B62(0.230017)	13.14456	6.57228
B46	0.023845	B63(1.000000)	16	0.099026	B19(0.152801); B5(0.006972); B57(0.840227)	10.098311	10.098311
B47	0.030418	B63(1.000000)	16	0.106382	B19(0.128576); B57(0.814295); B62(0.057129)	9.400105	9.400105
B48	0.03397	B63(1.000000)	16	0.111182	B19(0.110861); B57(0.777254); B62(0.111885)	8.994261	8.994261
B49	0.036117	B63(1.000000)	16	0.207476	B19(0.119907); B57(0.358002); B62(0.522091)	9.639669	4.819835
B50	0.228929	B57(0.500000); B63(0.500000)	100.5	0.494624	B5(0.024574); B57(0.975426)	6.442337	12.130418
B51	0.18125	B57(0.300000); B63(0.700000)	66.7	0.338569	B5(0.017705); B57(0.982295)	6.318692	11.814435
B52	0.148214	B57(0.200000); B63(0.800000)	49.8	0.277952	B19(0.043817); B5(0.003125); B57(0.953058)	7.195482	10.793222
B53	0.142966	B62(0.750000); B63(0.250000)	46.75	0.645024	B19(0.093532); B57(0.036326); B62(0.870142)	9.301973	1.550329
B54	0.088682	B62(0.250000); B63(0.750000)	26.25	0.450436	B19(0.079456); B57(0.106116); B62(0.814428)	8.880288	2.220072
B55	0.072072	B63(1.000000)	16	0.139725	B19(0.030658); B57(0.609558); B62(0.359784)	7.156891	7.156891
B56	0.08377	B63(1.000000)	16	0.144339	B19(0.020673); B57(0.588680); B62(0.390647)	6.928143	6.928143
B57	1	B57(1.000000)	185	1	B57(1.000000)	6	11
B58	0.192398	B57(0.100000); B63(0.900000)	32.9	0.196626	B57(0.917160); B63(0.082840)	5.751479	10.171598
B59	0.119403	B63(1.000000)	16	0.280171	B19(0.015691); B57(0.253786); B62(0.730523)	7.138489	3.569244
B60	0.323009	B62(0.500000); B63(0.500000)	36.5	0.675773	B19(0.017734); B57(0.044432); B62(0.937834)	7.39893	1.479786

B61	0.16	B63(1.000000)	16	0.187245	B57(0.434060); B62(0.259605); B63(0.306334)	5.340602	5.340602
B62	1	B62(1.000000)	57	1	B62(1.000000)	7	1
B63	1	B63(1.000000)	16	1	B63(1.000000)	3	1
Sector C							
C1	0.104113	C2(0.357676); C5(0.030384); C8(0.611940)	139823.7058	0.978967	C2(0.378440); C8(0.621560)	50.05277	19.408217
C2	1	C2(1.000000)	387000	1	C2(1.000000)	37	48
C3	0.086202	C11(0.684274); C5(0.295318); C8(0.020408)	1132.260504	0.479825	C2(0.026706); C5(0.746903); C8(0.226391)	20.840928	16.672742
C4	0.039885	C11(0.666667); C13(0.333333)	189.333333	0.1517	C2(0.006179); C5(0.239318); C8(0.754503)	46.143664	6.591952
C5	1	C5(1.000000)	3100	1	C5(1.000000)	9	20
C6	0.356036	C11(0.709484); C5(0.127251); C8(0.163265)	923.201681	0.482471	C2(0.000020); C5(0.464578); C8(0.535402)	35.235254	10.36331
C7	0.025224	C13(1.000000)	62	0.081465	C11(0.118378); C5(0.564267); C8(0.317355)	24.55038	12.27519
C8	1	C8(1.000000)	2139	1	C8(1.000000)	58	2
C9	0.447788	C11(1.000000)	253	0.616901	C11(0.890411); C5(0.109589)	9	4.863014
C10	0.23221	C13(1.000000)	62	0.324297	C11(0.995083); C5(0.004917)	9	3.083597
C11	1	C11(1.000000)	253	1	C11(1.000000)	9	3
C12	1	C12(1.000000)	89	1	C12(1.000000)	1	2
C13	1	C13(1.000000)	62	1	C13(1.000000)	3	1
Sector D							
D1	1	D1(1.000000)	65718	1	D1(1.000000)	27	20
D2	1	D2(1.000000)	14000	1	D2(1.000000)	38	17
D3	0.076595	D10(0.204545); D32(0.272727); D36(0.522727)	846.681818	0.35	D1(0.021978); D10(0.978022)	14.285714	20
D4	0.387417	D10(0.783784); D32(0.054054); D34(0.162162)	3016.432432	0.800836	D1(0.062868); D10(0.930171); D2(0.006960)	14.984339	19.979119
D5	0.626762	D10(0.466667); D2(0.133333); D25(0.400000)	4136	0.75889	D10(0.513128); D2(0.316446); D25(0.170426)	21.083422	15.812567
D6	0.539501	D10(0.636364); D32(0.181818); D36(0.181818)	2471.454545	0.700555	D1(0.011363); D10(0.983359); D2(0.005279)	14.274403	19.984164
D7	0.006569	D36(1.000000)	30	0.1	D10(1.000000)	14	20
D8	0.972362	D2(0.222222); D25(0.777778)	4053.777778	0.985892	D2(0.231232); D25(0.768768)	17.243275	4.699718
D9	0.007641	D36(1.000000)	30	0.15	D10(1.000000)	14	20
D10	1	D10(1.000000)	3824	1	D10(1.000000)	14	20
D11	0.007853	D36(1.000000)	30	0.125662	D10(0.234861); D2(0.155970); D25(0.609169)	15.915769	7.957885
D12	0.195318	D10(0.159091); D32(0.545455); D36(0.295455)	714.863636	0.35433	D10(0.818114); D2(0.024326); D25(0.157560)	14.111156	16.933387
D13	0.008636	D36(1.000000)	30	0.141548	D10(0.654676); D2(0.043164); D25(0.302160)	14.129468	14.129468
D14	0.009055	D36(1.000000)	30	0.112076	D10(0.865314); D36(0.134686)	12.383764	17.845018
D15	0.009099	D36(1.000000)	30	0.072586	D10(0.646332); D2(0.031028); D25(0.322641)	13.776742	13.776742
D16	0.408483	D10(0.157895); D25(0.429825); D34(0.412281)	1149.061404	0.648668	D10(0.201079); D2(0.084124); D25(0.714797)	13.874594	6.166486

D17	0.013717	D36(1.000000)	30	0.161022	D10(0.253652); D2(0.024434); D25(0.721914)	12.420671	6.210336
D18	0.17897	D10(0.052632); D25(0.087719); D34(0.859649)	358.298246	0.486662	D10(0.134834); D2(0.034236); D25(0.830930)	12.328882	4.109627
D19	0.026185	D34(0.666667); D36(0.333333)	49.333333	0.339785	D10(0.257139); D2(0.000028); D25(0.742833)	11.772162	5.886081
D20	0.172894	D10(0.054054); D32(0.486486); D34(0.459459)	320.891892	0.447555	D10(0.300163); D25(0.578393); D34(0.121444)	11.171823	6.703094
D21	0.194833	D10(0.052632); D25(0.087719); D34(0.859649)	358.298246	0.501203	D10(0.140219); D2(0.020390); D25(0.839391)	11.971189	3.990396
D22	0.016565	D36(1.000000)	30	0.174281	D10(0.249362); D25(0.705249); D34(0.045389)	11.475753	5.737876
D23	0.179519	D10(0.062500); D36(0.937500)	267.125	0.492676	D10(0.384291); D36(0.615709)	6.611492	10.148656
D24	0.02449	D36(1.000000)	30	0.135983	D10(0.298960); D32(0.336800); D34(0.364240)	7.353839	7.353839
D25	1	D25(1.000000)	1212	1	D25(1.000000)	11	1
D26	0.624585	D10(0.052632); D25(0.421053); D34(0.526316)	742.631579	0.796917	D10(0.079456); D25(0.720596); D34(0.199948)	10.038682	2.50967
D27	0.031746	D36(1.000000)	30	0.254494	D10(0.241170); D36(0.758830)	4.894043	7.858724
D28	0.0375	D36(1.000000)	30	0.275967	D10(0.202952); D36(0.797048)	4.435424	7.247232
D29	0.058027	D36(1.000000)	30	0.330373	D10(0.128361); D36(0.871639)	3.540327	6.053769
D30	0.097403	D36(1.000000)	30	0.386669	D10(0.073274); D36(0.926726)	2.879283	5.172377
D31	0.10101	D36(1.000000)	30	0.780337	D10(0.070374); D36(0.929626)	2.844491	5.125988
D32	1	D32(1.000000)	179	1	D32(1.000000)	4	3
D33	0.245902	D36(1.000000)	30	0.683686	D10(0.024249); D36(0.975751)	2.290986	4.387981
D34	1	D34(1.000000)	59	1	D34(1.000000)	5	1
D35	0.967742	D36(1.000000)	30	0.95082	D34(0.034483); D36(0.965517)	2.103448	3.896552
D36	1	D36(1.000000)	30	1	D36(1.000000)	2	4

Efficiency score is calculated for each DMU within their sector. Based on the table, DMUs that have the score of 1 will be identified as efficient in the Analysis. Accordingly, 6 efficient units are identified in Sector B: B19, B2, B5, B57, B62 and B63; 6 in Sector C: C13, C2, C5, C8, C12 and C11; and 7 in Sector D: D1, D10, D2, D25, D32, D34 and D36. It is also shown in the table that all the efficient units identified in the analysis are consistent between input and output orientation model. This has been noted in DEA studies that changes in input and output orientated model will change the projection value for inefficient units on efficient units, but won't affect the forming of sets of efficient units (Charnes et al., 1994 and Copper et al., 2007). Moreover, in the results of DEA, the 'best performing' DMUs create an envelopment surface, also known as efficiency frontier. The level of inefficiency of other DMUs is measured against this frontier. In this study, analysis for DMUs in each sector is run differently, hence, there will be one unique frontier for each of the three sectors.

Besides the DMUs on each frontier, the DMUs that have scores lower than 1 is considered to be inefficient in their given context. It is worth noting that the purpose of

the score in the results is not to give ranking to all the DMUs, but rather, it is a suggestion for the degree of inefficiency, i.e. lack of capability, comparing to their benchmarks. Considering the fact that the results indicate an efficiency frontier rather than an efficiency point, inefficient DMUs will have different ways to move towards the frontier. Consequently, for every inefficient DMUs a benchmark set (in some case it is been called reference set) has been provided and the score is calculated based on the benchmark set rather than based on the whole sample. Hence, the results should be considered more as benchmarking rather than ranking because for each inefficient DMUs the benchmark set may be different. Taken into account how the efficiency scores are calculated, there is also differences in the scores between input and output orientated model. Generally, input orientated model is to contracts the inputs as far as possible while maintaining the same level of outputs. Whereas output orientated model aims at expanding the outputs as far as possible while controlling the inputs (Charnes et al., 1994). Consequently, although the efficient DMUs are unchanged, there will be a different benchmark set for inefficient DMUs because the way for each DMU to move towards the frontier may be different.

How inefficient DMUs can move towards the efficiency frontier is reflected on the projection value. In the input orientated model, the projection value indicates the level of input each DMUs has to reduce to while maintaining the same level of outputs, whereas in the output orientated model the projection value suggest the level of output that each DMU has to reach without increasing the input. For DMUs that have only one other DMU as benchmark set, the optimised level of either input or output will totally be the same as the benchmark set. In other case, the projection value will depend on all DMUs in the benchmark set, with the value 'lambda' indicating the percentage each DMU weight in the set. For example, for the benchmark set of B1 in input orientated model, B57 weight 40% and B63 weight 60% in the reference set. The projection value for B1 here is calculated by 40% times the original input value from B57 plus 60% times the original input value from B63.

Overall, the results have provided a relative position for every DMUs within their sector, no matter being efficient and on the frontier or not efficient but also can have a relevant movement towards frontier. It also shows that scores can be significantly different for a certain DMU between input and output orientated model. This will be discussed further in the following section.

DISCUSSION

Ambidextrous organisations

Reflecting on the discussion in the literature review, ambidexterity in a capability based approach as organisations that 1) have both exploration and exploitation and 2) able to maintain efficiency in both exploration and exploitation. Based on the sampling process and the logic of DEA, all the DMUs that are in the analysis have both patents with and without self-citation, hence, they are considered to have both exploration and exploitation, meeting the first condition. Moreover, all the DMUs that have the efficiency score of 1 is identified as efficient in transforming input to both outputs, therefore, they can be regarded as able to maintain efficiency in both exploration and exploitation, meeting the second condition. Consequently, DMUs that have an efficient score of 1 can be identified as ambidextrous organisations.

Taking a closer look at the relationship between efficiency scores, and the actual amount of input, efficiency scores and total amount of patents, and efficiency scores with exploration and exploitation, it is notable that ambidexterity does not necessarily mean high level of input or outputs. Figure 2, Figure 3 and Figure provides a distribution chart for these relationships Based on Sector B, Sector C and Sector D respectively.

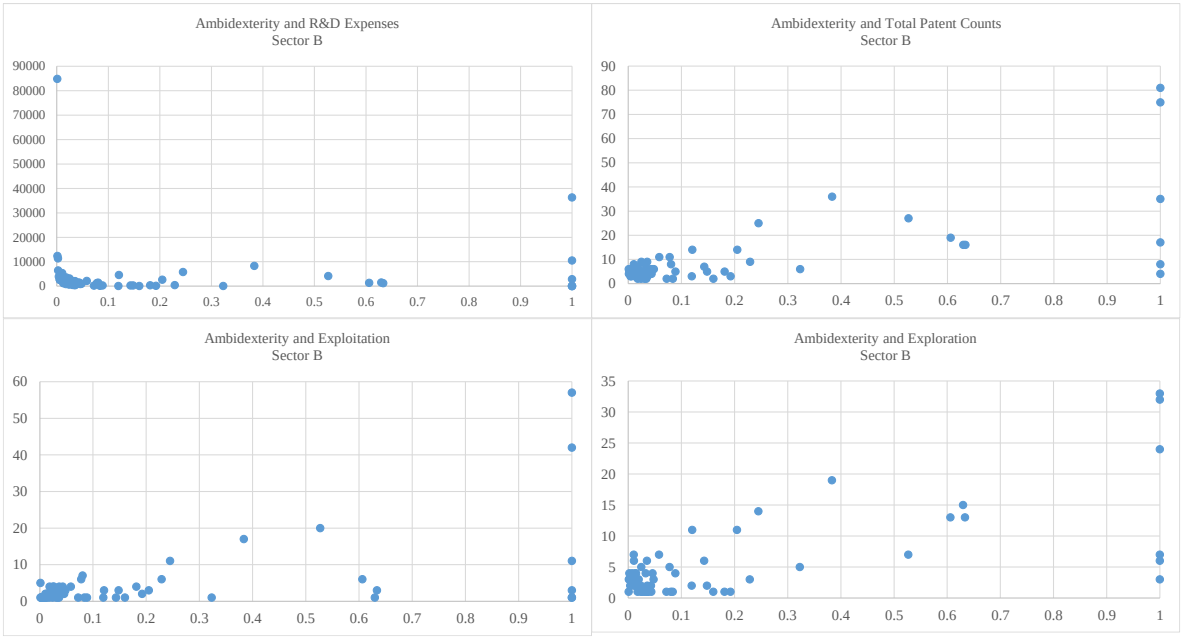

Figure 2 Distribution Chart Sector B

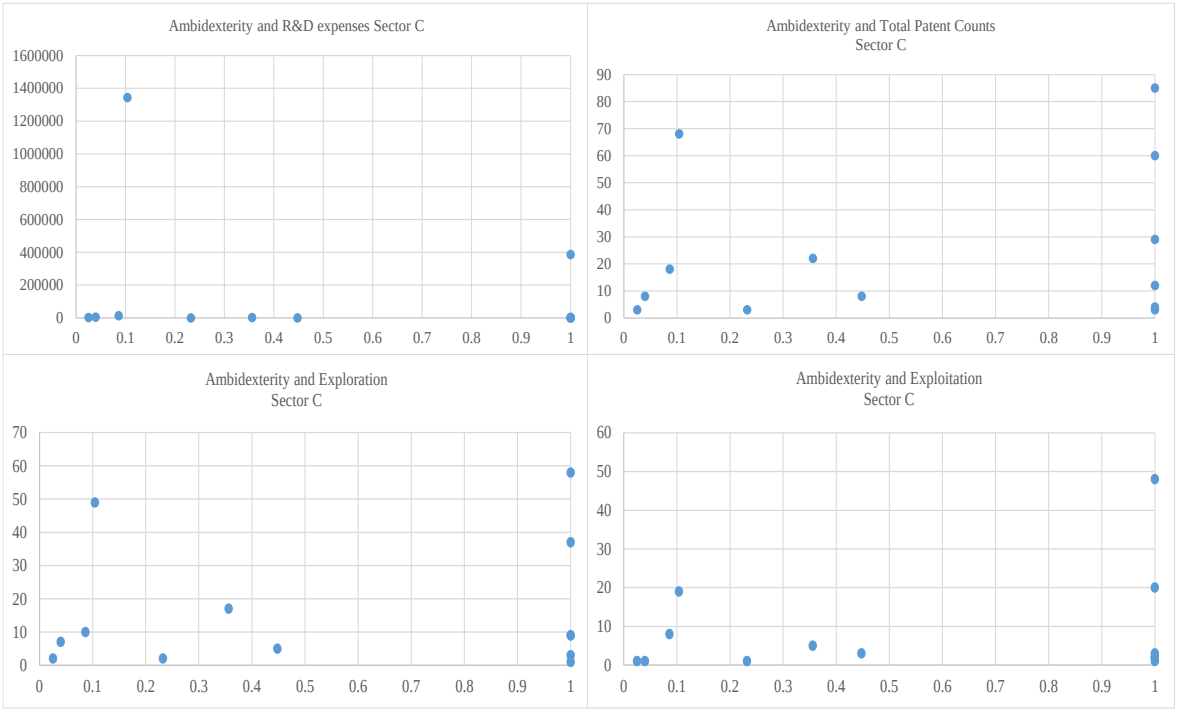

Figure 3 Distribution Chart Sector C

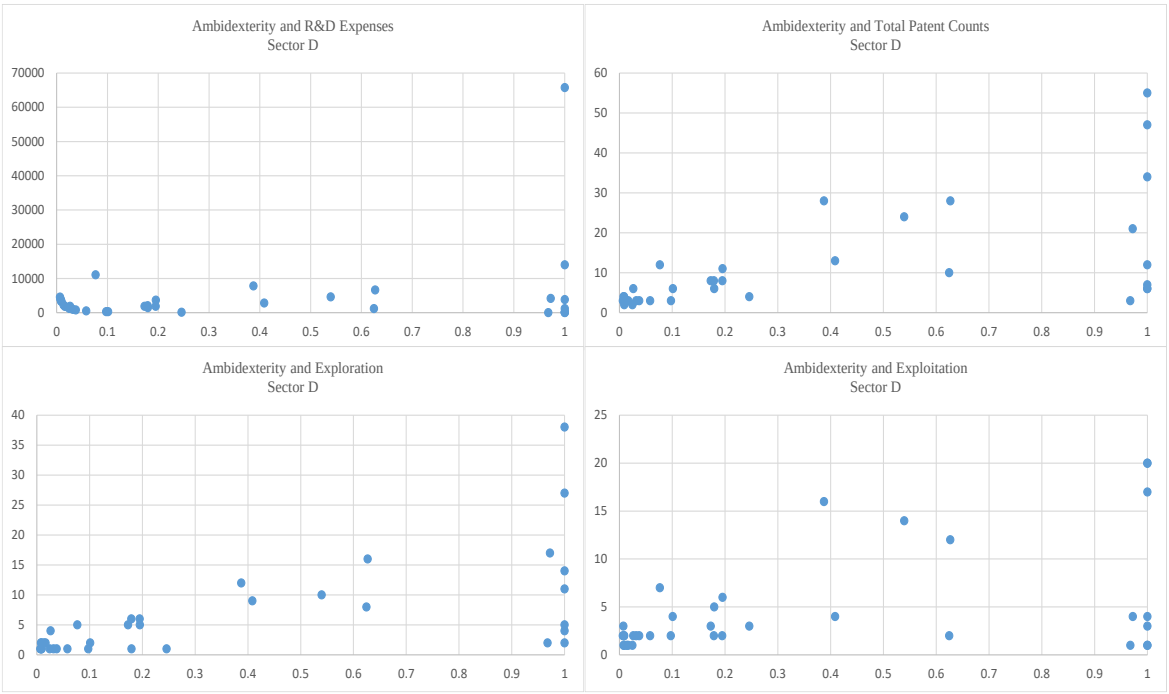

Figure 4 Distribution Chart Sector D

Overall, the distribution is relativity even across different levels of inputs and outputs. This is to say that there is no significant liner relationship between the actual amount of inputs and outputs with ambidexterity. To be more specific, first, regarding the ambidexterity and input. According to Figure 2, it is indicated that in sector B and sector C, the DMU that has the highest level of R&D expenses is not identified as ambidexterity. This is reasonable considering the uncertainty in R&D activities and it has also been proven by previous studies that high level of R&D expenses does not guarantee high level of R&D outputs (Baumann and Kritikos, 2016; Hall and Bagchi-sen, 2002). Second, in terms of the overall amount of output, it is shown in figure 3 that high level of output is likely to lead to ambidexterity. However, there are also ambidextrous organisations identified with relatively low level of overall outputs. Last, there is not significant difference between relationship of exploration and exploitation with ambidexterity. Therefore, exploration and exploitation should be considered equally important in achieving ambidexterity.

Becoming Ambidexterity

Without looking into the detail processes and management of innovation, the results have pointed out rough estimation on how each organisation in the study can move towards ambidexterity. Considering the logic behind DEA, it should be noted that there is not a universal way for each organisation to become ambidextrous because of the difference between their own benchmark set. For the input changing, the proposed way is that organisation can reduce the amount of R&D expenses while maintaining the level of innovation output to become ambidexterity. Whereas for the output changing, since this study take patents as an indicator, the suggestion to view it in as a ‘percentage way’ rather than focusing on the actual amount. Take B6 as an example, according to the projection value given by Table 5, B6 can achieve ambidexterity by reaching the level of exploration at around 29 and exploitation around 26. Considering the original level of

output for B6 is exploration at 19 and exploitation at 17, to become ambidexterity, B6 has to increase its exploration and exploitation both by around 65%.

Also, the input and output orientated model provided two different way of thinking in becoming ambidexterity. For some organisations, considering the original value for the input level, it may be a situation that one of the way is not suitable. Take B1 who has the highest amount of input as an example. Taking an input oriented approach will require the reduction of R&D expense for 84,716,400 Euro. This is basically impossible considering the original level of input that the organisation has been putting into R&D. Hence, this paper suggest that without looking into detailed managerial practice, it is important to understand the current status of the organisation before making decision on how to achieve ambidexterity. Either input or output focused approach will allow organisations moving towards ambidexterity, the importance also lies in finding the right benchmark sets.

To sum up, this paper proposes that taking a more capability based approach to identify ambidexterity may be beneficial in the following ways. First, a capability based approach is able to identify the ambidextrous organisations that have lower level of input or output amount. Considering the impact of size and scale on innovation, this approach is more comprehensive comparing to solely outcome based approaches. Second, this approach is also able to provide a relative benchmark for every organisations in the analysis according to the capability frontier. This may be more realistic than outcome based approaches in some circumstance since the each organisation is given a specific benchmark set. Third, this approach also provide possible ways to become ambidexterity from the input aspects, which most outcome based approaches might not able to provide.

CONCLUDING REMARKS

Summary

To get more insight on the studies of ambidexterity, this study has proposed DEA as a useful method to identify ambidextrous organisations. Taking exploration and exploitation as R&D capability, this paper proposes to identify organisations that with an efficiency score of 1 as ambidexterity. Also, the results have also provided a benchmark set and way to move towards frontier for each inefficient organisations. This could be a useful first step to use capability based approach to study ambidexterity, which will have implication for both practice and future research.

Implication for practice

This study offers implication for practice in two aspects. First, it provides a way that mangers can use to benchmark their organisations within the given context. This is not only applicable to understand the place of their organisation within the sector, but also helpful to understand the position of their competitors. Second, this study provides a rough estimation on how to become ambidexterity, by taken into consideration their own organisations' status, it will be beneficial for mangers to decide whether to focus on make changes on the input or the output side.

Future Research

As a first step, this study takes exploration and exploitation only as R&D capability with simple measures. Future studies may extend the current model from two aspects. First, introduce more input and output measures. Possible items may include R&D personal

from the input side, and patent quality from the output side. Second, expend the meaning and implication of exploration and exploitation to other important capability that forms overall innovation capability. For example, in marketing capability, that how organisations could commercialise innovation outcomes. This may lead to the use of multi stage DEA models. Also, this study used sectors as context, however, the data is not significant enough to prove the impact of context. The method for identifying ambidextrous organisations could also be applied within regional context, which provides possibility for understanding cultural effect on ambidexterity.

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