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Organisational Ambidexterity in UK High-Tech SMEs: An Exploratory Study of Key Drivers and Barriers

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Abstract

Purpose: This study is to explore the nature of organisational ambidexterity, and identify drivers of and barriers to ambidexterity in the high-tech SMEs in the UK, using fine-grained qualitative evidence. This is much needed to generate insights on how organisational ambidexterity actually takes place in SMEs.

Design/methodology/approach: This study is exploratory in nature, based on qualitative in-depth interview data collected from 20 UK high-tech SMEs in five industries.

Findings: The results reveal that SMEs leverage resources through intra-firm and inter-firm collaborations to pursue ambidexterity sequentially or simultaneously, using a range of drivers and overcoming a range of barriers.

Research limitations/implications: The data were gathered from a single informant from each firm. Therefore, more in-depth, longitudinal, qualitative research using multiple sources of data may be required to develop deeper insights into ambidexterity.

Practical implications: Managers of high-tech SMEs need to focus on specific barriers to ambidexterity and devise effective mechanisms to promote the drivers of ambidexterity. The mechanisms to achieve ambidexterity as identified in this study will benefit high-tech SMEs in particular, and firms in general.

Originality/value: The study contributes to the understanding of organisational ambidexterity in high-tech SMEs by exploring the mechanisms through which SMEs implement organisational ambidexterity despite their resource constraints. This counteracts the conventional view that it is difficult for SMEs to pursue ambidexterity.

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Introduction

Organisational ambidexterity is grounded in March's (1991) work on exploratory and exploitative learning. Exploratory learning involves "search, variation, risk taking, experimentation, play, flexibility, discovery," while exploitative learning entails "refinement, choice, production, efficiency, selection, implementation, execution" (March, 1991:71). Subsequently, exploration and exploitation have been further researched (e.g. Ardichvili et al., 2003; Auh and Menguc, 2005, 2008; Brady and Davis, 2004; Holmqvist, 2004; Ireland and Webb, 2007; Rodan, 2005), informing the development of the concept of organisational ambidexterity (Tushman and O'Reilly, 1996). Organisational ambidexterity refers to a firm's capability of both exploring new competences and exploiting existing competences (Gibson and Birkinshaw 2004; Raisch et al. 2009; Simsek et al. 2009; Tushman and O'Reilly 1996, 1997). Firms that possess a higher level of exploratory and exploitative capabilities are called ambidextrous firms (O'Reilly and Tushman, 2008; Tushman and O'Reilly, 1996).

Ambidexterity has been described as 'a much lauded, but rarely achieved, organizational capability' (Andriopoulos and Lewis, 2009: 708). It is acclaimed because of its association with improved firm performance (Ireland and Webb, 2007); overlooking exploitation over exploration or *vice versa* may harm short-term or long-term firm performance (March, 1991). In particular, the turbulent environment, especially in high-tech sectors, means that firms have no choice but to be ambidextrous: exploiting existing capabilities for efficiency and exploring new capabilities for innovation (Sarkees and Hulland, 2009). Empirical evidence reveals that ambidexterity is positively related to firm performance (He and Wong, 2004), especially in high-tech firms (Wang and Rafiq, 2014). For instance, IBM developed the 'IBM

Business Leadership Model' (Harreld et al., 2007, p.28) that promoted both exploration and exploitation to cope with the threat of the emergence of the personal computer (PC) that posed a long-term threat to IBM and caused a drastic fall in IBM share prices (Flamholtz and Randle 1998). This included strategic and cultural changes in IBM, and the company made a good progress (Flamholtz and Randle 1998) under this (ambidextrous) approach. However, the implementation of ambidexterity comes with critical challenges and barriers, given the need to manage organisational complexity in consistent yet paradoxical ways (Andriopoulos and Lewis, 2009).

The question as to whether ambidexterity is viable in different types of firms remains. Prior literature suggests that ambidexterity may work better in some firms but not in others. For example, Voss and Voss (2013) found that product ambidexterity (product exploration and exploitation) and market ambidexterity (market exploration and exploitation) have positive effects on revenue in older and larger but, not younger and smaller firms. This could be because the older firms have the resources, capabilities, and experience required to implement as well as benefit from ambidexterity (Voss and Voss, 2013). Similarly, Ebben and Johnson (2005) reckoned that, given their limited resources as compared to those in larger firms, small manufacturing firms should not attempt to pursue ambidexterity as this could lead to poor performance. Instead, they should follow either efficiency (offering standard products) strategy or flexibility (offering made-to-order products) strategy. Pursuing ambidexterity might dilute their limited resources of small firms (Voss and Voss, 2013).

On the other hand, some studies have revealed that being ambidextrous is particularly important for small and medium-sized enterprises (SMEs). Just like larger firms, SMEs face competitive pressures to jointly pursue exploitation and exploration (Lubatkin et al., 2006), especially in highly dynamic environments (Chang et al., 2011). By fostering ambidexterity, firms benefit from a higher perception of customer capital, for example, in

telecommunications SMEs (Cegarra-Navarro and Dewhurst, 2007). The line of argument for ambidexterity is that SMEs are better positioned to achieve a strong top management team behavioural integration, which contributes to organisational ambidexterity (Lubatkin et al., 2006). However, there is insufficient evidence on how exploration and exploitation occurs in SMEs and what factors affect SMEs' ability to balance exploration and exploitation. Therefore, this study aims to answer the research questions: What are the key drivers of, and barriers to, organisational ambidexterity in high-tech SMEs? What are the mechanisms to implement organisational ambidexterity in high-tech SMEs?

Drawing on evidence from a qualitative, exploratory case study of 20 UK high-tech SMEs, this study aims to contribute to the organisational ambidexterity literature in the field of strategic management by postulating the nature of ambidexterity in high-tech SMEs and by identifying drivers of, and barriers to, organisational ambidexterity. Organisational ambidexterity is challenging but attainable (Tushman and O'Reilly, 1996, 1997). Existing literature has identified mechanisms that facilitate the implementation of organisational ambidexterity, such as through structural and temporal separation (Gupta et al., 2006; Simsek et al., 2009; Tushman and O'Reilly, 1996), meta-routines (Adler et al., 1999), behavioural contexts (Gibson and Birkinshaw, 2004), and organisational culture (Wang and Rafiq, 2014). However, these mechanisms often apply to large firms, but not necessarily to SMEs due to the lack of slack resources that can help SMEs manage paradoxical processes (Lubatkin et al., 2006). Therefore, the present study aims to contribute to the understanding of organisational ambidexterity in SMEs.

Organisational ambidexterity

It is no doubt that exploration and exploitation require different organisational mechanisms. Exploration-oriented firms use a wide range of strategic and operational mechanisms, such as

use of mergers and acquisitions to gain full control over valuable, diverse resources and knowledge; use of strategic alliances to tap into external resources whilst mitigating the risks associated with mergers and acquisitions; and use of corporate venture capital to invest in new technologies. Exploration-oriented firms may also use structural mechanisms with decentralised authority and semi-standardised procedures/semi-formalised processes, as well as adoption of cultures that promote experimentation and risk-taking, and tolerate failure (Ireland and Webb, 2007). In addition, exploration-oriented firms have a 'visionary and involved' leadership (O'Reilly and Tushman 2004:80).

In contrast, exploitation-oriented firms often adopt strategic and operational mechanisms such as use of mergers and acquisitions to gain full control over valuable distribution channels and achieve economies-of-scale and -scope; and use of strategic alliances to expand a firm's knowledge and resources to accurately and quickly target global opportunities (O'Reilly and Tushman 2004). They tend to focus on internal development of intimate knowledge held by employees involved in exploitative activities leading to incremental innovation, and are also characterised by centralised authority, standardised procedures, formalised processes, culture that values certainty of outcomes, preference for short-term goals, and 'more authoritative' and 'top-down' leadership (O'Reilly and Tushman 2004:80).

Given the different nature of exploration and exploitation, earlier literature warns against the trade-off effect between them: exploration and exploitation may compete for limited organisational resources, and as a result, exploration may crowd out exploitation or *vice versa*, which could in turn undermine short-term or long-term firm performance (March, 1991). Organisations have to assess risks associated with exploration and exploitation, and accordingly allocate resources; such risk assessment often involves intertemporal, interinstitutional, and interpersonal comparisons (March, 1991). According to this view, exploration and exploitation have to be separated structurally and/or temporally (Gupta et al.,

2006; Simsek et al., 2009). Structural separation requires that exploration and exploitation are pursued in different business units, but coordinated by the top management (e.g. Adler et al., 1999; Benner and Tushman, 2003; Smith and Tushman, 2005; Jansen et al., 2008). Temporal separation means that exploration and exploitation take place at different times within the same business unit to avoid the high demand for resources (Gupta et al., 2006).

However, structural separation might be relevant to firms of all sizes except new start-ups in their early stage (Benner and Tushman, 2003). Simsek et al. (2009) point out that the majority of structural ambidexterity research has examined structural partitioning and integration of exploitation and exploration across multiple units within a single organisation (e.g. across divisions of a multidivisional corporation). When it comes to independent units and SMEs with limited resources, intellectual capital resources might be the foundation for ambidexterity (Simsek et al., 2009) and in particular, a complementary alignment among components of intellectual capital drives ambidextrous learning – simultaneous exploratory and exploitative learning (Kang and Snell, 2009). Alternatively, small firms could specialise solely in either explorative or exploratory activities under different conditions, in which case the logic of ambidexterity between exploration and exploitation can be extended beyond a single organisation (Gupta et al., 2006; Benner and Tushman, 2003).

Nevertheless, subsequent studies have not always supported the trade-off effect (e.g. Greve, 2007). Instead, scholars have identified the complementary effect of exploration and exploitation (Birkinshaw and Gibson, 2004), and indeed there can be a co-evolutionary relationship between exploration and exploitation (Zollo and Winter, 2002). In particular, the concept of contextual ambidexterity (Birkinshaw and Gibson 2004; Wang and Rafiq, 2014) or harmonic ambidexterity (Simsek et al. 2009) emphasises the integration of exploration and exploitation within a single business unit but allows for differentiated effort in both activities. Individuals within the business unit are encouraged to make own judgement about how to

divide time between exploratory and exploitative activities and to integrate both activities (Gibson and Birkinshaw 2004). According to this view, the key to managing exploration and exploitation is not about using structural and temporal measures to separate them, but to achieve an optimal *balance* between exploration and exploitation or a *combination* of high levels of exploration and exploitation (Junni et al., 2013). In particular, research suggests that the highest performance is associated with a combination of exploitation and exploration at their highest levels (Lubatkin et al., 2006). There is a plethora of evidence supporting the organisational benefits of contextual ambidexterity (e.g. Gibson and Birkinshaw 2004; Chang et al. 2009; Kang and Snell 2009; Wang and Rafiq, 2014). Ambidextrous firms are the most successful and more than 90% of ambidextrous firms achieved their organisational goals (O'Reilly and Tushman, 2004). Nevertheless, in the SME context, there is dearth of research on the applicability of different types of ambidexterity – being structurally or temporally separated or simultaneous, and what drives or hinders different types of ambidexterity in SMEs.

Drivers of and barriers to ambidexterity: large firms vs. SMEs

Resource endowment is a key driver for ambidexterity in larger firms (Kyriakopoulos and Moorman, 2004; Raisch and Birkinshaw, 2008; Venkatraman et al., 2007). In contrast, the constraint of firm resources in SMEs has been highlighted as a key barrier to adopting some of the facilitating mechanisms of ambidexterity widely used in large firms (Lubatkin et al., 2006). For example, due to lack of resources and hierarchical administrative systems, SMEs may not be able to manage exploration and exploitation by creating structurally separate business units dedicating to exploration or exploitation (Lubtakin et al., 2006). This leads Lubatkin et al. (2006) to argue that top managers, who are likely to play both strategic and operational roles in SMEs, are crucial to the integration of exploration and exploitation by

synchronising processes to promote collaborative behaviour. The resource constraint also means that SMEs would have to use their resources creatively to pursue organisational ambidexterity, for example, by engaging in inter-firm collaboration (Kauppila, 2010), to balance exploration and exploitation across alliances (Lavie and Rosenkopf, 2006).

Another key driver for ambidexterity is the role of the top management team (TMT), widely identified in the literature. For example, Jansen et al. (2008) discuss the specific features of the role of the senior executives in balancing conflicting forces in ambidextrous organisations, based on evidence from Dutch branches of a large European financial services firm. However, the role of TMT could have a stronger influence on ambidexterity in SMEs than in large firms. Particularly unlike in SMEs, outcomes at larger firms are often influenced by factors extraneous to the TMT (e.g. multiple product lines and markets, complex organisational systems, independent board of directors, capital markets) (Lubatkin et al., 2006). Therefore, Lubakin et al. (2006) anticipate that the statistical associations between TMT behavioural integration, ambidexterity, and relative firm performance may be stronger in SMEs.

However, as pointed out by Assink (2006), factors like lack of competencies and mandatory internal or external infrastructure might hamper disruptive innovations even in large firms. In addition, Nicholas et al. (2013) report that both large firms and SMEs that were identified as non-innovators, suffered from lack of qualified personnel, lack of systems to support innovation, lack of knowledge of lead users in the market and knowledge of targeting new markets that made them focus on current work at the expense of exploratory search. Sfirtsis and Moenaert (2010) present three categories of barriers to achieving ambidexterity, i.e. knowledge-based (e.g. tacitness of knowledge making it difficult to detect), cognitive (differences in attitudes inhibiting the communication), and organisational barriers (e.g. intra-organisational boundaries). Even though Sfirtsis and Moenaert's (2010)

discussion seems to be in the context of large firms, barriers such as knowledge-based and cognitive might be equally relevant to SMEs as well. Other barriers discussed in the literature include lack of trust in outsourcing partnerships, lack of individual motivation, and external and internal regulations that were reported by Kalgovas et al. (2014) in a qualitative study among chief information officers mostly from SMEs. These studies prompt us to further examine the nature of organisational ambidexterity, its key drivers and barriers in high-tech SMEs.

Methods

This study is based on an exploratory case study of 20 UK high-tech SMEs in 2011. High-tech SMEs were selected as the sample of the study due to their advanced knowledge and capabilities in technology, educated workforce, and flexibility in responding to fast changing environments (Crick and Spence, 2005); their practical relevance in the context of current economic climate where firms are looking for new opportunities (Economist Intelligence Unit, 2013); and their policy relevance to economic growth where SMEs play a key role in the UK economy (CBI, 2011). More importantly, just like large firms, SMEs, especially those operating in dynamic environments in high-tech sectors, face competitive pressures to pursue exploitation and exploration concurrently, but the lack of resources and hierarchical administrative systems required to manage such contradictory knowledge processes poses particular challenges for SMEs to pursue organisational ambidexterity (Lubatkin et al., 2006). Therefore, high-tech SMEs provide a meaningful and relevant context for studying organisational ambidexterity.

SMEs are defined to include micro firms (< 10 employees), small firms (10–49 employees) and medium-sized firms (50–249 employees) (European Commission, 2005). High-tech firms are defined as those with a Standard Industrial Code (SIC) that falls into one

of the five high-tech industries (OECD, 2003): aerospace; pharmaceutical and bio-technology; office and computing; radio, TV and communication; and medical and optical equipment. The sample of the study consisted of 20 high-tech firms whose senior executives were willing to participate in the case study, out of a total of 113 firms that were contacted. Twenty semi-structured interviews with executives, one executive from each firm, were conducted in 2011. The interviewees were identified by the respective case firms as the most qualified available person to talk about the overall operations of the case firms even though some of them happened to manage some functional areas of the firms in some cases. Our interview questions were designed to give more prominence to the case than the interviewee while acknowledging that the way interviewee sees the case operating is essential knowledge, and we found out the background of the interviewee to understand his/her interpretations as well (Stake, 2013). The interview questions covered firm background, self-assessment of firm resources and capabilities, core business (exploratory and exploitative) activities, key drivers of and barriers to organisational ambidexterity, etc. Each interview, around 60 minutes long on average, was recorded and transcribed. Table 1 summarises the case firms.

Insert Table 1 here

Data were coded and analysed in a four-stage process guided by Glaser and Strauss (1967) and Miles and Huberman (1994). First, within each case, data were manually coded by the first author and checked by the co-author to identify initial, broad categories relevant to exploration, exploitation and ambidexterity between them. These initial, broad categories formed the first-order concepts following Corley and Gioia (2004) and Gioia et al. (2012). Second, the links among the first-order concepts were explored and grouped them into second-order themes (Corley and Gioia, 2004). Themes and patterns on drivers for

ambidexterity, barriers to exploration, barriers to exploitation, and barriers to achieving ambidexterity were allowed to emerge. Third, cross-case comparisons were conducted using standard cross-case analysis techniques (Eisenhardt, 1989; Miles and Huberman, 1994). Themes and patterns within each case emerged in the second stage were compared, and similar themes and patterns were gathered into aggregate dimensions. Fourth, a theoretical framework of the nature of ambidexterity, a table of drivers of and barriers to ambidexterity drawing on the findings and prior literature to advance the understanding of drivers for and barriers to ambidexterity, and a typology of ambidexterity between exploration and exploitation in UK high-tech SMEs were developed. The data structure is presented in Figure 1.

Insert Figure 1 here

Results

The analysis of interview data reveals some interesting findings. The results on the nature of ambidexterity in the sample firms, drivers of ambidexterity, and barriers to ambidexterity related to those firms are reported below.

The nature of ambidexterity in UK high-tech SMEs

The findings reveal that an SME may leverage resources within the firm or across firms to pursue ambidexterity (Table 2). This provides support for Kauppila's argument (2010) that ambidexterity can occur *intra-firm* or *inter-firm* through creative resource combination and deployment. The findings also show that ambidexterity can occur *simultaneously* or *sequentially* in SMEs, in line with Venkatraman et al. (2007). The simultaneous process can punctuate, as described by Gersick (1991) and Gupta et al. (2006), with high exploration and low exploitation periods, or low exploration and high exploitation periods. As pointed out by

O'Reilly and Tushman (2013: 327) what is missing in the research by the proponents of sequential ambidexterity is 'how sequential ambidexterity occurs and what the transition looks like'. Findings of this study shed some light on this.

When further analysing *intra-firm ambidexterity* in the case firms, case firms M&O-3, O&C-2 and RT&C-3 followed a *simultaneous* process in balancing exploration and exploitation activities.

> "R&D departments and other manufacturing departments are sitting very close to each other…Most of the development work we do is in response to customer feedback…I think the company has done very well in developing new products…We are looking for new products and new techniques all the time"(Marketing Manager, M&O-3)

> "Innovation is at the heart of the company. You know, we have to have solutions you can't buy form anybody else…And then the customer says I would like to buy if you do this. And then we change it. You know, it is kind of dialogue between us and the customer to try and identify exactly what the customer wants to buy." (Executive Chairman, O&C-2)

> "Primary research is done over the other factory and the guys are scientists…They are always investing in research. They do a lot of research in new products. We don't really need to [advertise]. It is all word of mouth. People see our products." (Commercial Manager, RT&C-3)

It was also found that within intra-firm ambidexterity, it was found that firms Aero-1 and O&C-4 had a balanced approach where the exploration and exploitation activities followed a *sequential* (cyclical) process.

> "At the moment [resources allocated for R&D are] pretty high…We are looking at new markets for our existing product lines." (Chief Executive Officer, Aero-1)

> "...The technology is applicable to many other areas. [But] we would rather focus on the current core markets where we can do best and then migrate to other markets as the technology matures…Since kind of designing a technology, the three generations of hardware we deployed has really been incremental improvements to that core technology…The business has always taken an end to end approach." (Lead Architect-Hardware Systems, O&C-4)

Confirming prior findings in biotechnology firms that engaged in exploration alliances as well as exploitation alliances (Rothaermel and Deeds, 2004), there was evidence that in firms M&O-2 and RT&C-1, *inter-firm ambidexterity* occurred in a *simultaneous* manner.

> "We have radically new products in the pipeline that support and replace our existing line of products. We have other new ideas to develop a new product…At the moment we rely on our distribution network to actually do the marketing about our products around the world." (Chief Administrator, M&O-2)

> "It is difficult to be in this industry unless we are really up there. We do lots of [business with] contract manufacturers [who use RT&C-1's technology], people who assemble their PCBs [printed circuit boards], and sell them onto their customer base."(Sales Director, RT&C-1)

In firms M&O-1 O&C-3 and P&B-5, *inter-firm ambidexterity* also occurred in a *sequential* manner.

> "When we moved from importing, distributing other people's products and decided to set up our own factory to start manufacturing, we hired people and used external companies who have the skills to help us develop products." (Managing Director, M&O-1)

> "We develop our own technologies and we are not into building products on that…We did partnerships with [a firm] and we have a couple of potential partnerships with other institutions." (Managing Director, O&C-3)

> "Because that was a technology that was problematic, [and] we had done it very effectively…Now we are focusing on exploiting opportunities…Developing a relationship with [a firm] provided a route to market." (Executive Chairman, P&B-5)

Insert Table 2 here.

In summary, the above findings reveal that ambidexterity can occur intra-firm or inter-firm through creative resource combination and deployment among high-tech SMEs that can happen simultaneously or sequentially in SMEs. The simultaneous process can punctuate with high exploration and low exploitation periods, or low exploration and high exploitation periods.

The drivers of ambidexterity in UK high-tech SMEs

The findings reveal two sets of key drivers of organisational ambidexterity: key drivers within organisational boundaries included *flexibility within the firm* and *collective decision-making within the firm*; and key drivers across organisational boundaries included *opportunity for strategic alliances, opportunity for acquisitions* and *limited competition in the market*.

Flexibility contributes to a higher level of ambidexterity as a higher level of flexibility in coordinating and using resources enables firms to conduct a high level of exploration and exploitation (Wei, Yi and Guo, 2014), and firms with flexibility are able to provide customised product/service (Kortmann et al., 2014). For example, being flexible has enabled firms Aero-1, M&O-2, O&C-3 and P&B-5 to be ambidextrous:

> "Being small and quick to react… Being a small firm is good and being able to act quickly is a good competitive differentiator…We can scale our technology...You know, we can increase our production by putting new capacity without having corresponding increase in personnel overhead." (CEO, Aero-1)

> "Lot of time and effort gone into improving and adapting our infrastructure to meet those requirement." (Chief Administrator, M&O-2)

> "We are flexible to what customer needs and whereas customer changes, we reconfigure ourselves to address the requirements of different customers…The advantage of having clever people is, it is just easy to change. Because we are a small company."(Managing Director, O&C-3)

> "Well, we changed our management team to fit in with the requirements of our collaborating partner." (Executive Chairman, P&B-5)

Collective decision making is the next driver of ambidexterity. A firm attempting to develop and commercialise a new technological innovation requires organisational units to work together (Taylor and Helfat, 2009). Through joint decision making, a top management team is better able to build an ambidextrous organisation (Carmeli and Halevi, 2009). Respondents from firms M&O-1, O&C-2 and O&C-4 illustrated this point.

> "One of the key things is we restructured in terms of the new product development team, marketing and sales headed by one person. So they are linked up together. So, they are not separate. And then we removed the barrier between the two" (Managing Director, M&O-1)

> "We have some quite strong sort of IT systems to help us sharing the information across the company. And we have a lot of meetings...And, then we are very open minded about the new stuff." (Executive Chairman, O&C-2)

> "Core technical team do lot of travelling to customer sites to help with deployments. We have a lot of feedback. We have lot of regular meetings between core management, regional management and product management. I mean, it is really communicating as much information as possible." (Lead Architect-Hardware Systems, O&C-4)

Firms can be more ambidextrous via *strategic alliances*. Firms that balance exploration and exploitation via alliances gain profits and market value (Lavie et al., 2011), go beyond their boundaries (Dyer and Singh, 1998), and overcome the conflicting activities of exploration and exploitation (Lavie and Rosenkopf, 2006; Rothaermel and Deeds, 2004). Firms M&O-1, P&B-5 and RT&C-1 shared insights on how to benefit from alliances:

> "We used external companies who have the skills to help us develop products... We had the distributor side that gave us knowledge of the market side." (Managing Director, M&O-1)

> "The main challenge for the company was raising initial capital funding to develop its products…Developing a relationship with [a firm] provided us with their source of funding…The reasons for [same firm] developing a relationship with us [was] to get access to the technology for measuring protein in blood." (Executive Chairman, P&B-5)

> "We do lots of [business with] contract manufacturers [who use RT&C-1's technology]."(Sales Director, RT&C-1)

Moreover, firms tend to engage in *acquisitions* as they provide firms with access to new knowledge (Harrison et al., 1991; Kim and Finkelstein, 2009; Vermeulen and Barkema, 2001), and then assimilate such knowledge by integrating it with existing knowledge leading to the firm's growth. The interviewee from O&C-4 claimed that:

> "We developed, and really, that enabled us to grow the business through mergers and acquisitions, and organic growth."(Lead Architect-Hardware Systems, O&C-4)

Even though growing competitive pressures demands exploration (Levinthal and March, 1993), that could put too much pressure on small firms given their resource limitations. However, those firms who engage in advanced research and development can create first-mover's advantage and temporarily create a niche market where there is *limited competition*. Such firms can then exploit commercial benefits, benefiting from their exploratory research and development. This was evident in firms M&O-3, O&C-2 and RT&C-3.

> "Medical market is…My experience is always slow moving anyway…So, nothing has been happening in the last 6 years…Things happen very slowly in the medical market." (Marketing Manager, M&O-3)

> "In the B2B [business to business] market in the industry where there are, probably 30 customers in the world. So, marketing is not very important." (Executive Chairman, O&C-2)

> "We build expert systems to suit the customers' needs. There are not many companies that do [RT&C-3's product]…[the competition] is not that aggressive…Because, in this industry, it is mostly relying on research and development...developing new products." (Commercial Manager, RT&C-3)

The barriers to ambidexterity might make firms focus on either exploration or exploitation alone, leading to failure traps (Levinthal and March, 1993) or success traps (Levinthal and March, 1993; Wang et al., 2015). Therefore, next, what stands in the way of achieving ambidexterity in UK hi-tech SMEs will be examined.

Barriers to ambidexterity in UK high-tech SMEs

The study also identified some possible barriers to ambidexterity between exploration and exploitation in high-tech SMEs. The barriers emerged can be broadly grouped into three: *barriers to exploration, barriers to exploitation*, and *barriers to balancing exploration and exploitation*.

Barriers to exploration

Four exploration related factors that could have a negative effect on ambidexterity emerged in the data analysis: *complacency, focus on incremental changes, limited expertise, and government spending cuts*. The interview data manifest the presence of the above factors in the case firms.

Some firms have been complacent due to various reasons that seem to have prevented them from exploring. For example, the leaders of SMEs get complacent the firms will be outpaced by the competition (Blumentritt, 2004). As the sales engineer of Firms Aero-2 and P&B-4 put it:

> "We are very much, you know [into] customer-based innovation…We are just service orientated…We manufacture [customers' own products] to meet customer specifications". (Sales Engineer, Aero-2)

> "You find that scientists [in P&B-4] like to work with what they are familiar with. So, innovation has to be in a very small sect. Which means that generally speaking lot of products last for quite a long time." (CEO, P&B-4)

Another barrier to exploring is their *focus on incremental changes*. Those SMEs could be mainly exploitation-oriented and adaptable to the existing customers' needs (Harry and Schroeder, 2000). However, as compared with the exploration-oriented firms, the above firms' returns are not sustainable (Hamel, 2000; Lubatkin et al., 2006) as they run the risk of obsolescence (Lubatkin et al., 2006). Firms Aero-2 and Aero-4 seem to be driven by such mindset.

> "So, they [technologies] don't change that much. But, what you do is, keep updating and changing our manufacturing process. So, you know, constantly adapt the process to improve the product. Rather than been revolutionary it is more evolutionary." (Sales Engineer, Aero-2)

> "We are quite pragmatic in our approach. We improve something [according to customer needs] and that is the philosophy I would like to bring forward" (Marketing Manager, Aero-4)

The case firms tend to avoid exploration activities due to *limited expertise* that plays a key role in determining the SMEs capacity to innovate (Chaston et al., 2000). Data from Firms P&B-4 and RT&C-2 illustrated this.

> "The people you have don't have the same resources. Often you don't have the best talent in a small company. You got a lot of challenges." (CEO, P&B-4)

> "In fact, we have actually lost two engineers. We haven't replaced them at the moment. We prefer the management to work beyond the full capacity. We can't afford, cash flow dictate to us. We can't afford to take on more engineers. Basically our engineers do role of one and a half." (Finance Director, RT&C-2)

Another exploration related barrier that arises from the institutional environment is *government spending cuts*. For example, firms like Aero-3 and P&B-2 view this as a major challenge:

> "[A key challenge is] cuts in government funding for programmes. Government cuts in defence." (Business Development Manager, Aero-3)

> "What begins to have more impact on us is, now research funding in universities, etc. is obviously being cut. That is one of our major markets. So, that is a challenge." (Managing Director, P&B-2)

Barriers to exploitation

The study found three exploitation related barriers that could prevent the firms form being ambidextrous: *cost of inputs and manufacturing, the burden of managing patents, competition from emerging markets,* and *the need for developing new markets*.

The *cost of inputs and manufacturing* could be related to managing the general cost base of the firm, this was a barrier, for example, for firms Aero-2 and P&B-4.

> "Cost and raw materials [are the main challenges]…[and] controlling them…We cope by the way we purchase our material and the way we manage the cost base of the company." (Sales Engineer, Aero-2)

> "E-procurement, the cost of raw material, the cost of supplies from, you know, finished goods from suppliers…And, you know, we are not totally immune from the economic crisis." (CEO, P&B-4)

Another barrier emerged in the analysis was the *burden of managing patents* for reasons such as different regulatory barriers and legal and other costs associated with possible patent infringements by larger firms. Respondents from firms O&C-5 and P&B-3 reported facing this challenge.

> "After 2006, more money was put into the company. Then we started obtaining patents by continuously growing…Then, we are developing a portfolio of patents…Some of our competitors, we believe, are infringing our patents. So, we have started talking to them." (Research Director, O&C-5)

> "Everything we do can be very new and very bespoke. We sign over all work we do to the customer…We don't patent them and try to make money…We are not really in the business to patent." (Bioanalytics Project Manager, P&B-3)

The case firms face growing *competition from the emerging markets* that seems to limit the firms' ability to compete. As respondents from P&B-1 and P&B-3 summarised:

> "We are expensive. We are in the UK. We can't compete with India and China." (Managing Director, P&B-1)

> "The key challenge is to keep doing the testing we offer and stay ahead of our cheaper competitors."(Bioanalytics Project Manager, P&B-3)

The *need to develop new markets* is another challenge and networking plays a key role in identifying new markets. As the interviewees from O&C-1 claimed:

> "We need to find more prospects by attending networking events and gain better lead generation." (IT Consultant, O&C-1)

Another interesting finding related to the above barrier was *the level of customers' readiness* to embrace new product/service that could determine the success or failure of the new product/service. The following interview quotes form O&C-4 and O&C-5 illustrate this.

> "So, it is complicated...the market, and working out which one to go into…Going into a market that is quite either not ready for it or the customers are not quite ready for it." (Lead Architect-Hardware Systems, O&C-4)

> "I think at the moment where the customers have not experienced this type of technology, we probably would actually not know about what customers do and don't do." (Research Director, O&C-5)

Barriers to balancing exploration and exploitation

Four specific barriers to balancing exploration and exploitation could also be identified: *limited resources, changes in collaborating firms, bureaucracy and regulations,* and *reliance on organic growth*.

Limited resources can be seen as a common barrier to ambidexterity. Given their limited resources, small firms attempting to pursue both efficiency and flexibility could lead to poor performance (Ebben and Johnson, 2005) and such firms will dilute their limited resources (Voss and Voss, 2013). For example, interviewees from firms O&C-5 and P&B-2 claimed:

> "As I said, one of the disadvantages is not having the resources to be able to move quickly and to get things around quickly than competitors." (Research Director, O&C-5)

> "There was certainly resource constraints in terms of how much investment the owners could put in. They weren't willing to get in a lot of outside investment. So, that became a constraint on growing the company beneath or above a certain level." (Managing Director, P&B-2)

Even though inter-firm/organisational collaboration (Rosenkopt and Nerkar, 2001) could be useful in attempting to achieve (inter-firm) ambidexterity, *changes in collaborating firms* seem to affect their ability to maintain ambidexterity as well. Such changes may lead to some compatibility issues between the collaborating companies (Kelly et al., 2002). In a dynamic environment, there can be issues that cannot be forecast and that cause changes in collaborating firms (Blomqvist et al., 2005). Firms O&C-5 and P&B-2 seemed to face this challenge.

> "Because it is dependent on mobile phones as the platform trying to run the applications on and that is very fast moving…We were concentrating very much on [a mobile phone brand]…So, it was a lot of investments in 2008 into supporting [same brand]. Now actually what has happened is, once [same brand]

> started to get into trouble, for us, it was a major problem." (Research Director, O&C-5)
>
> "And, also R&D spending in some of the big pharmaceutical companies [P&B-2 is collaborating with] is under pressure. So, that is a challenge." (Managing Director, P&B-2)

The other factor under the common barriers to ambidexterity in the case firms is *bureaucracy and regulations*. For example, the slow approval process might discourage innovations by the firms. This barrier does not limit to the national level; it also extends to the regional and global levels. As the respondents from firms Aero-4, P&B-1, P&B-4 and RT&C-2 put it:

> "It is quite hard to become a new entrant. Because, you need to build a reputation, and it is not just with the customers, we also need to have a very good reputation with the certification authorities." (Marketing Manager, Aero-4)
>
> "The regulations required by the MHRA [Medicines & Healthcare Products Regulatory Agency, UK] have increased over the last 10 years."(Managing Director, P&B-1)
>
> "The problem we have is that the system often within the university often doesn't allow the end users to work with a small company…You have procurement managers and head of the procurements who often dictate the behaviour of the end users of the whole institution. That is one of the biggest threats for a small independent company in this market in the UK." (CEO, P&B-4)
>
> "So, what is happening now is under new EU regulation which is something that kills companies like us, they are obliged to, over a certain level, go out for tender." (Finance Director, RT&C-2)

Another barrier to balancing exploration and exploitation was *reliance on organic growth* that might suit only exploration activities (Kuckertz et al., 2010). Reliance on organic growth could discourage firms' form achieving growth through strategic alliance or acquisitions that could facilitate both exploration and exploitation. When the market slows, the reliance on organic growth of firms could affect their ability to maintain, for example, sequential ambidexterity (Chen and Katila, 2008). The effect of the above barrier was evident in firms P&B-2 and P&B-3.

> "The other key challenge has to be some consolidation in the industry. There are some companies who have been very acquisitive. They are buying three or four companies a year and growing. So, I think, seen how that works out, it is going to be quite a challenge."(Managing Director, P&B-2)

> "We didn't become global by acquisition…[P&B-3 try] to grow through organic growth. But, that is very difficult…We do get a form of organic growth…[But,] trying to outstrip the organic growth and get more growth than [what] the market is providing is very difficult." (Bioanalytics Project Manager, P&B-3)

The above findings on the nature of ambidexterity in SMEs, their key drivers and barriers have implications for theory and practice, which will be discussed below.

Discussion

The findings provide insights on the nature of ambidexterity (Figure 2), and the key drivers of and barriers to ambidexterity in the high-tech SMEs (Table 3). First, in the sample UK high-tech SMEs, there was evidence for both simultaneous and sequential ambidexterity, as widely recognised in the literature (e.g. Gibson and Birkinshaw, 2004; O'Reilly and Tushman, 2008; Tushman and O'Reilly, 1996). As far as *the structure* of ambidexterity that relates to where ambidexterity is pursued is concerned, the study found that such simultaneous or sequential ambidextrous processes took place within firm or across firms as suggested by Kauppila (2010) and Gupta et al. (2006); the latter could be in the forms of exploratory alliances or exploitative alliances (Rothaermel and Deeds, 2004).

Insert Table 3 here

These findings push boundaries of conventional research on intra-firm ambidexterity (Tushman and O'Reilly, 1996; O'Reilly and Tushman, 2008; Benner and Tushman (2003), and instead, draw attention to inter-firm ambidexterity as a way to overcome resource constraints in SMEs. In understanding inter-firm ambidexterity, insights could be gained form

the model of open innovation (Chesbrough, 2003) where a firm exploits its own innovations as well as those of others; there is a porous boundary between the firm and its environment that enables innovations to move across (Chesbrough, 2003). It can also be understood that inter-frim ambidexterity could be well achieved through adopting open business models by using external ideas and technologies to develop products internally and by letting internal ideas and technologies to be commercialised externally (Chesbrough, 2007). Open business models could help firms to cope with challenges such as rising development costs and shorter product life cycles (Chesbrough, 2007). Even though the model of open innovation and open business models were originally introduced focussing on large corporations, Van de Vrande et al. (2009) found that SMEs engage in many open innovation practices in technology exploration (e.g. venturing, outward intellectual property licensing, employee involvement) and exploitation (e.g. customer involvement, external networking, external participation, outsourcing R&D, inward intellectual property licensing).

Insert Figure 2 here

As far as *the strategy* of pursuing ambidexterity is concerned, both simultaneous ambidexterity and sequential ambidexterity were evident in the findings (Figure 3). Firms may start with either exploration or exploitation and then move on to engage in both exploration and exploitation (see Venkatraman et al., 2007), and this process can punctuate (Gersick, 1991) with high exploration and low exploitation periods and *vice versa*. The findings of our study help to answer O'Reilly and Tushman's (2013) question on how sequential ambidexterity occurs and the nature of the transition. The findings on the reciprocal/cyclical nature of ambidexterity confirm the complementary relationship between exploration and exploitation (Greve, 2007; Zollo and Winter, 2002). Thus, as presented in

Figure 3, based on our findings and inspired by Simsek et al. (2009), we developed a typology of ambidexterity in high-tech SMEs along two dimensions strategy and structure that groups ambidextrous firms (ten of the 20 case firms were identified as ambidextrous, i.e. 50%) in the sample into four groups: *inter-simultaneous* (20% of the ambidextrous firms), *intra*-simultaneous (30% of the ambidextrous firms), *inter-sequential* (30% of the ambidextrous firms), and *intra-sequential* (20% of the ambidextrous firms).

Insert Figure 3 here

Second, a range of key drivers that enable some firms to pursue ambidexterity were identified. For example, flexibility in coordinating and using resources and collective decision-making within a firm, opportunities for strategic alliances and acquisitions across organisational boundaries, and creating niche markets to limit competition. Flexibility of resources, coordination, and strategy etc. could enable firms to respond to customer needs while pursuing exploring new opportunities (Wei et al., 2014; Kortmann et al., 2014). *Collective decision making* that facilitates linkages between organisational units (Taylor and Helfat, 2009) is another key driver of ambidexterity (Carmeli and Halevi, 2009). *Strategic alliances* are another driver that enables firms to exploration and exploitation (Lavie et al., 2011, Rothaermel and Deeds, 2004) and to go beyond their boundaries (Dyer and Singh, 1998). Firms also engage in *acquisitions* that give them access to new knowledge that can be integrated and exploited (Harrison et al., 1991; Vermeulen and Barkema, 2001). Finally, disputing Levinthal and March's (1993) claim related to growing competitive pressures and exploration, in a less competitive industry, small firms seems to focus on both exploration and exploitation.

Third, those firms that are mostly into exploitation could be trapped by their own success (Levinthal and March, 1993; Wang et al., 2015), whereas those that purely engage in exploration could lead to failure traps (Levinthal and March, 1993). Therefore, as the next objective of the study, barriers to achieving ambidexterity in UK high-tech SMEs were examined. The findings reveal three sets of barriers: barriers to exploration, barriers to exploitation and barriers to balancing exploration and exploitation.

As far as the barriers to exploration are concerned, the effects of six factors were presented above: *complacency; focus on incremental changes; limited expertise;* and *government spending cuts.* Firms could stick to exploitative activities due to risk-averse mind-set of the top management. Nicholas et al. (2013) identified risk averse culture as the most prominent barrier to exploration in large firms and SMEs in high-tech and low-tech industries. Firms could become *complacent* and also *focus on incremental changes* in risk averse cultures. With regards to *limited expertise*, for example, Assink (2006) proposes that lack of adequate follow-through competencies and infrastructure can be an inhibitor to disruptive innovation. Lack of qualified personnel and systems to support innovation can make firms focus on exploitation and not on exploration (Nicholas et al., 2013). These findings support Simsek et al. (2009) and Kang and Snell's (2009) claims that intellectual capital resources might be the foundation for ambidexterity in SMEs firms. *Government spending cuts* that play a key role in promoting R&D (Romijn and Albaladejo, 2000) is the next barrier to exploration. The UK government's cutbacks in research spending (Cuntz (2012) have negative effects on SMEs.

The barriers to exploitation make some firms focus largely on exploration. One of the barriers is *the cost of inputs and manufacturing* that plays a significant role in determining the profit margins of firms. Branzei and Vertinsky (2006) found that higher levels of price-cost margins stimulated the development of novel capabilities in the competitive environment; a cost-based strategy may increase the performance of manufacturing SMEs (Terziovski,

2010). Some of the sample firms prefer to avoid the *burden of managing patents* due to high cost of managing patents, particularly in Europe (Van Pottelsberghe de la Potterie and Mejer, 2010). Both the cost of acquiring and maintaining patents is a burden on firms (Hall et al., 1999; Kingston, 2006) and firms' anticipated cost of defending patents has an impact on their R&D investments (European Union, 2000). Such barriers in making effective use of intellectual property rights could affect SMEs' ability to exploit their innovations (Burrone, 2005). The *competition from cheaper competitors* in the existing markets, and *developing new markets* are the other two barriers to exploitation identified. The increased competition from cheaper products from countries like China, India, Mexico, Brazil and Turkey where 70.9% of world production comes (United Nations Industrial Development Organization-UNIDO, 2013). The above barrier also includes identifying new markets, coping with underdeveloped customers/markets–innovative users play an entrepreneurial role in contributing to radical innovations (Lettl et al., 2006), and having effective marketing communication. In addition, due to the limited usefulness of existing networks in entering new markets, the UK high-tech SMEs have to develop new networks (Crick and Spence, 2005).

Finally, it was also identified some common barriers to balancing exploration and exploitation: *limited resources; changes in collaborative partners; bureaucracy and regulatory requirements;* and *reliance on organic growth.* Due to *lack of resources*, managers have to make a choice between exploration and exploitation (March, 1991; Levinthal and March, 1993) and resource endowment can moderate organisational ambidexterity (Raisch and Birkinshaw, 2008). Next, c*hanges in collaborative partners* in inter-firm exploration and exploitation collaborations could undermine the ability to achieve ambidexterity. Since all the collaborating partners are not equally adept at learning (Hamel, 1991), for example, technological changes could cause differences due to a partner not being able to embrace the

changes. In addition, *bureaucracy and regulatory requirements* related to industries, countries, and regions seem to affect the high-tech SMEs' ability to maintain ambidexterity between exploration and exploitation. These could be, for example, frequent administration-related problems in the Netherlands (Van de Vrande et al., 2009), limited institutional support in the UK (Murray and Lott, 1995), or laws and regulations in China (Zhu et al., 2012). Finally, the *reliance on organic growth* could affect firms' ability to achieve ambidexterity. The firms in the fast-growing high-tech industry in China prefer growth paths such as partnership and acquisition to organic growth (Chen et al., 2009). Firms need both organic and acquisitive growth even for long-term growth (Lockett et al., 2011) as organic growth can be restricted by slow market growth (Chen and Katila, 2008).

Conclusion

This study explores the nature of ambidexterity and identifies drivers of and barriers to ambidexterity in the high-tech SMEs in the UK, using fine-grained qualitative evidence. This is much needed to generate insights on how ambidexterity actually takes place in firms. The study reveals that ambidexterity in high-tech SMEs could be a sequential or simultaneous process that can occur within or across firms' boundaries, and there are drivers of ambidexterity and barriers to ambidexterity that can be related to exploration, exploitation or balancing them. This qualitative study based on expert views of executives from 20 high-tech SMEs in the UK partly meets the methodology gap highlight by O'Reilly and Tushman (2013) in understanding ambidexterity and the drivers and barriers.

Being a cross-sectional study based on a single informant from each firm, our study may not have captured the full picture, although we made effort to maximise the generalisability (external validity) of findings in the context of UK high-tech firms by using multiple cases (Eisenhardt 1989; Miles and Huberman 1994). As far as the contextual generalisability

(Lukka and Kasanen, 1995) is concerned, we collected data on the specific nature of the context of high-tech SMEs including the business environment they were operating, and interpreted our findings in such context. As far as the analytical generalisation (Yin, 2003) is concerned, we attempted to generalise results of our study through grouping different drivers and barriers to ambidexterity between exploration and exploitation and also by trying to understand the nature of ambidexterity with a focus on different types of ambidexterity (Simsek et al. 2009) in high-tech SMEs. Despite our efforts, more in-depth, longitudinal, qualitative research using multiple sources of data may be required to get deeper insights into ambidexterity.

Overall, our findings have important theoretical and practical implications. High-tech SMEs must avoid focussing on either exploration or exploitation alone that could lead to failure traps (Levinthal and March, 1993) or success traps (Levinthal and March, 1993; Wang et al., 2015). Exploration-oriented high-tech SMEs might find it difficult to exploit their groundbreaking innovations by expanding into new markets (Brown and Eisenhardt, 1997) due to the risk involved as it may take a long time to realise returns (Lubatkin et al., 2006). Exploitation-oriented high-tech SMEs that exploit their existing technologies and markets (Harry and Schroeder, 2000) might enjoy short-term returns while facing the risk of falling into success trap in the long run. Large firms are able to adopt an ambidextrous strategy given their abundance of resources. In contrast, due to lack of resources, managers of high-tech SMEs need to focus on specific barriers to ambidexterity and devise effective mechanisms to promote the drivers of ambidexterity. Identifying the most efficient mechanisms (e.g. inter-firm collaborations to achieve sequential or simultaneous ambidexterity) to achieve ambidexterity for specific firms will particularly benefit high-tech SMEs.

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Table 1. The case firms

Industry	Firm	Year established	Core products	Location	Interviewee
Aerospace	Aero-1	2005	Coatings	Northamptonshire	Chief Executive Officer
	Aero-2	1980	Alloy ingots	West Midlands	Sales Engineer
	Aero-3	1969	Solutions for interconnects and electrical assemblies	Staffordshire	Business Development Manager
	Aero-4	1960	Aircraft interiors	Surrey	Marketing Manager
Medical and optical equipment	M&O-1	1964	Single use medical devices	Hertfordshire	Managing Director
	M&O-2	1988	Otoacoustic emissions instruments	Hertfordshire	Chief Administrator
	M&O-3	1956	Life support products	Greater London	Marketing Manager
Office and computing (it)	O&C-1	1991	Office communications solutions and IT services	London	IT Consultant
	O&C-2	2008	Intelligent wireless solutions	Hertfordshire	Executive Chairman
	O&C-3	2007	Web solutions	Cambridgeshire	Managing Director
	O&C-4	2003	Location solutions	Cambridgeshire	Lead Architect-Hardware Systems
	O&C-5	2006	Encoding technology	Cambridgeshire	Research Director
Pharmaceuticals and biotechnology	P&B-1	1947	Medicines and raw materials	Middlesex	Managing Director
	P&B-2	2006	Antibodies	Oxfordshire	Managing Director
	P&B-3	2008	Life science solutions	Oxfordshire	Bioanalytics Project Manager
	P&B-4	2001	Sample preparation products, consumables, and reagents	Berkshire	Chief Executive Officer
	P&B-5	2005	Biomarkers for neuropsychiatric illnesses.	Cambridge	Executive Chairman
Radio, TV and communication	RT&C-1	1991	Printed circuit boards	Devon	Sales Director
	RT&C-2	1985	Radio Frequency equipment	Waltham Abbey	Finance Director
	RT&C-3	2000	CCTV systems	Essex	Commercial Manager

Table 2. Characteristics of ambidextrous high-tech SMEs

Intra-Firm Ambidexterity	Inter-Firm Ambidexterity
▪ Higher resources allocation for R&D and looking at new markets for the existing product lines of the firm (e.g. Aero-1) ▪ Developing solutions customers cannot buy form anybody else and focusing on selling them in the niche market (e.g. O&C-2) ▪ Maintaining the technology competitive edge by continued investment in R&D and maintaining a disciplined approach to assessing markets (e.g. O&C-4) ▪ Primary research is done in one unit of the firm and another unit is dedicated to marketing (e.g. RT&C-3) ▪ Expansion of R&D and concentrating on prediction of developing markets and spotting new gaps in the markets (e.g. M&O-3)	▪ Using external firms' skills to develop products and designing and manufacturing by the firm (e.g. M&O-1) ▪ Having radically new products in the pipeline that support and replace the firm's existing line of products (e.g. M&O-2) ▪ Develop own technologies and getting partner firms build products on those technologies (e.g. O&C-3) ▪ Developing strategic relationship with firms to exchange funding for the innovative technology of the firm (e.g. P&B-5) ▪ Getting contract manufacturers use technologies of the firm and sell the products onto manufacturers' customer base (e.g. RT&C-1)

Source: Based on the interview data of the study.

Table 3. Drivers of and barriers to organisational ambidexterity in high-tech SMEs

Our findings related to high-tech SMEs				**Comparison with the extant literature**
Driver/barrier			***Sample case firms***	
Drivers of organisational ambidexterity	*Flexibility*		(20% of the firms) Aero-1, M&O-2, O&C-3, P&B-5	Concurred with the findings of quantitative studies among firms of mixed sizes in different industries in China by Wei, Yi and Guo (2014) and in India and the USA by Kortmann et al. (2014) that flexibility facilitates ambidexterity.
	Collective decision making		(15% of the firms) M&O-1, O&C-2, O&C-4	Supported Taylor and Helfat's (2009) and Carmeli and Halevi's (2009) conceptual work that proposes that the management plays a key role in creating and maintaining organisational ambidexterity.
	Strategic alliances		(15% of the firms) M&O-1, P&B-5, RT&C-1	Supported Dyer and Singh's (1998) view that a firm's critical resources may span firm boundaries, Lavie and Rosenkopf's (2006) argument that firms balance exploration and exploitation in their alliance formation decisions, and concur with Rothaermel and Deeds' (2004) findings that exploratory/exploitative alliances become less relevant as firms grow in size (As we found, such alliances drive ambidexterity in SMEs).
	Acquisitions		(5% of the firms) O&C-4	Differences in acquiring and target firms (like exploitation oriented firms and exploration oriented firms in our study) contributed to higher performance in a mixed sample of US firms (Harrison et al.,1991), Kim and Finkelstein's (2009) findings that suggested that complementarity (between exploitation and exploration in our study) is an important antecedent of acquisition performance in the US commercial banks.
	Limited competition		(15% of the firms) M&O-3, O&C-2, RT&C-3	Concurring with the view that growing competitive pressures that demand exploration that could put too much pressure on small firms given their resource limitations (e.g. Levinthal and March, 1993), we found that limited competition drives ambidexterity.
Barriers to organisational ambidexterity	***Barriers to exploration***	*Complacency*	(10% of the firms) Aero-2, P&B-4	Confirms the findings by Blumentritt (2004) that if the leaders of SMEs get complacent, the firms will be overtaken by the competition and by Nicholas et al. (2013) who identified that risk averse culture as a main barrier to exploration in large firms and SMEs in high-tech and low-tech industries.
		Focus on incremental changes	(10% of the firms) Aero-2, Aero-4	Supports Harry and Schroeder (2000) who concluded that exploitation-oriented SMEs are adaptable to the existing customers' needs. However, exploration-oriented firms' returns are not very sustainable as compared with exploitation-oriented SMEs (Hamel, 2000; Lubatkin et al., 2006) as they run the risk of obsolescence (Lubatkin et al., 2006). Further confirms the findings of Nicholas et al. (2013) who concluded that firms could stick to exploitative activities due to the top management's risk-averse mind-set in large firms and SMEs in high-tech and low-tech industries.
		Limited expertise	(10% of the firms) P&B-4, RT&C-2	Corroborates with the findings by Chaston et al., (2000) that existing evidence that SMEs tend to avoid exploration activities due to limited expertise and Simsek et al. (2009) and Kang and Snell's (2009) views that intellectual capital resources might be the foundation for ambidexterity.
		Government spending cuts	(10% of the firms) Aero-3, P&B-2	Confirms the existing findings that the UK government's cutbacks in research spending (Cuntz (2012) have negative effects on SMEs as government spending plays a key role in promoting R&D in SMEs (Romijn and Albaladejo, 2000).

	Barriers to exploitation	*Cost of inputs and manufacturing*	(10% of the firms) Aero-2, P&B-4	Agreed with the existing evidence that higher profit margins stimulated the development of novel capabilities (Branzei and Vertinsky, 2006) and a cost-based strategy could increase the performance (Terziovski, 2010) in manufacturing SMEs.
		Burden of managing patents	(10% of the firms) O&C-5, P&B-3	Corroborates with view that firms prefer to avoid the burden of managing patents due to high cost of managing patents in Europe (Van Pottelsberghe de la Potterie and Mejer, 2010) and in OECD countries (Burrone, 2005), and the findings by Hall et al., (1999) that both the cost of acquiring and maintaining patents is a burden on firms. This could affect SMEs' ability to exploit their innovations
		Competition form emerging markets	(10% of the firms) P&B-1, P&B-3	Agreed with the United Nations Industrial Development Organization-UNIDO (2013) report that competition comes from cheaper products from emerging markets where 70.9% of world production is concentrated that may limit UK high-tech SMEs ability to exploit.
		Need for developing new market	(10% of the firms) O&C-1, O&C-5	Our study confirmed the findings by Lettl et al. (2006) that innovative users play an entrepreneurial role in contributing to radical innovations high-tech industries and those firms would not be able to exploit their radical innovations effectively in underdeveloped customers/markets. This requires UK high-tech SMEs to expand into new markets.
	Barriers to balancing exploration and exploitation	*Limited resources*	(10% of the firms) O&C-5, P&B-2	Concurs with the findings that given their limited resources, small firms attempting to be ambidextrous could lead to poor performance (Ebben and Johnson ,2005) and dilution of their limited resources (Voss and Voss, 2013)
		Changes in collaborating firms/organisations	(10% of the firms) O&C-5, P&B-2	Even though inter-organisational collaboration (Rosenkopt and Nerkar, 2001) could be useful in achieving (inter-firm) ambidexterity, agreeing with evidence from Canadian high-tech firms including SMEs by Kelly et al.(2002) and from small software firms collaborating with global ICT firms by Blomqvist et al. (2005), our findings indicate that changes in collaborating firms could affect high-tech SMEs ability to maintain ambidexterity.
		Bureaucracy and regulations	(20% of the firms) Aero-4, P&B-1, P&B-4, RT&C-2	Corroborates with past research in the Netherlands (Van de Vrande et al., 2009), in the UK (Murray and Lott, 1995), and in China (Zhu et al., 2012).
		Reliance on organic growth	(10% of the firms) P&B-2, P&B-3	Supports Kuckertz et al., (2010) view that reliance on organic growth that might suit exploration activities, and Chen and Katila's (2008) argument that when the market slows, the reliance on organic growth of firms could affect their ability to maintain ambidexterity. That could be the reason why high-tech firms in China prefer growth through partnership and acquisition to organic growth (Chen et al., 2009).

Figure 1. Data structure

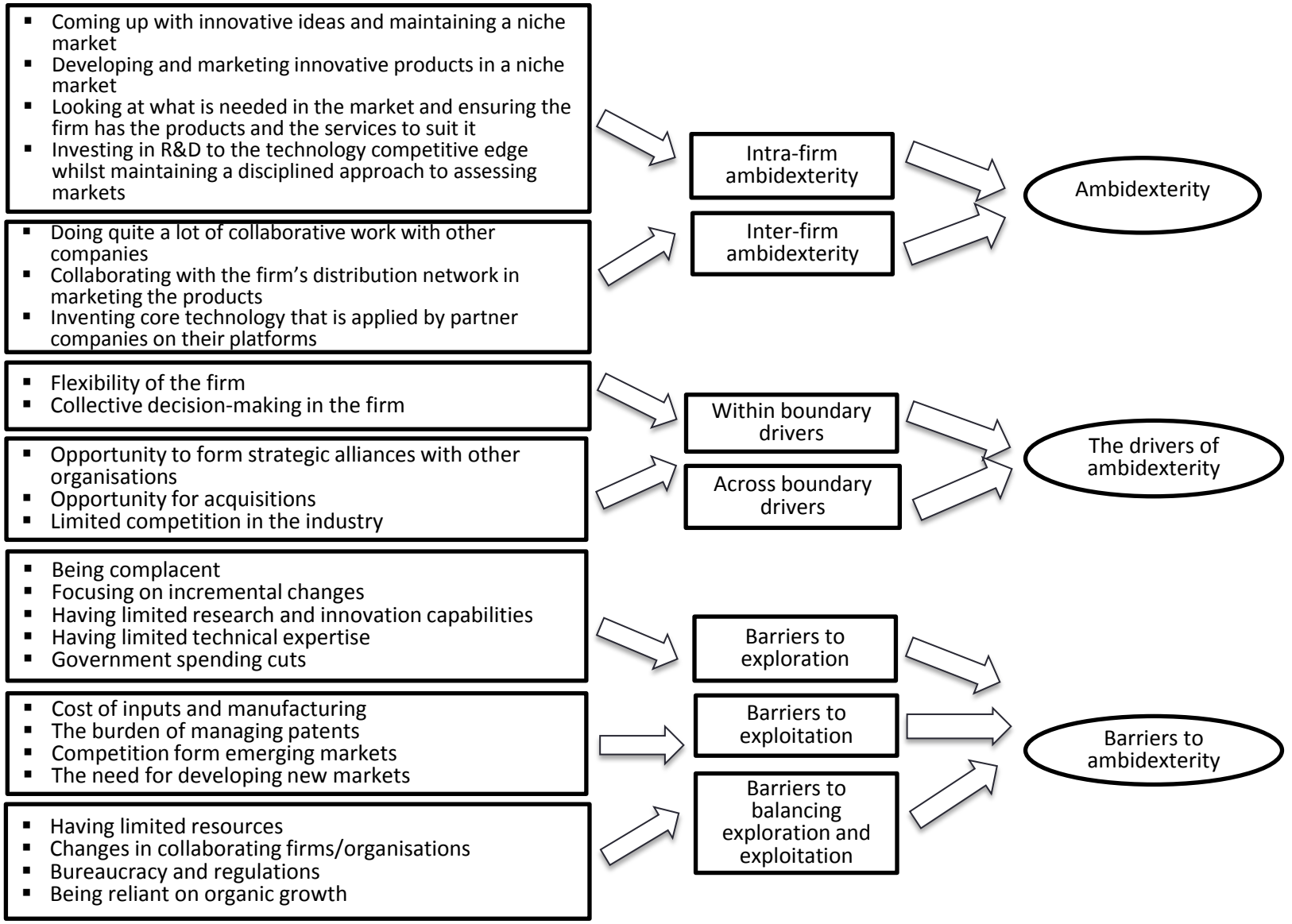

Figure 2. The nature of ambidexterity in high-tech SMEs

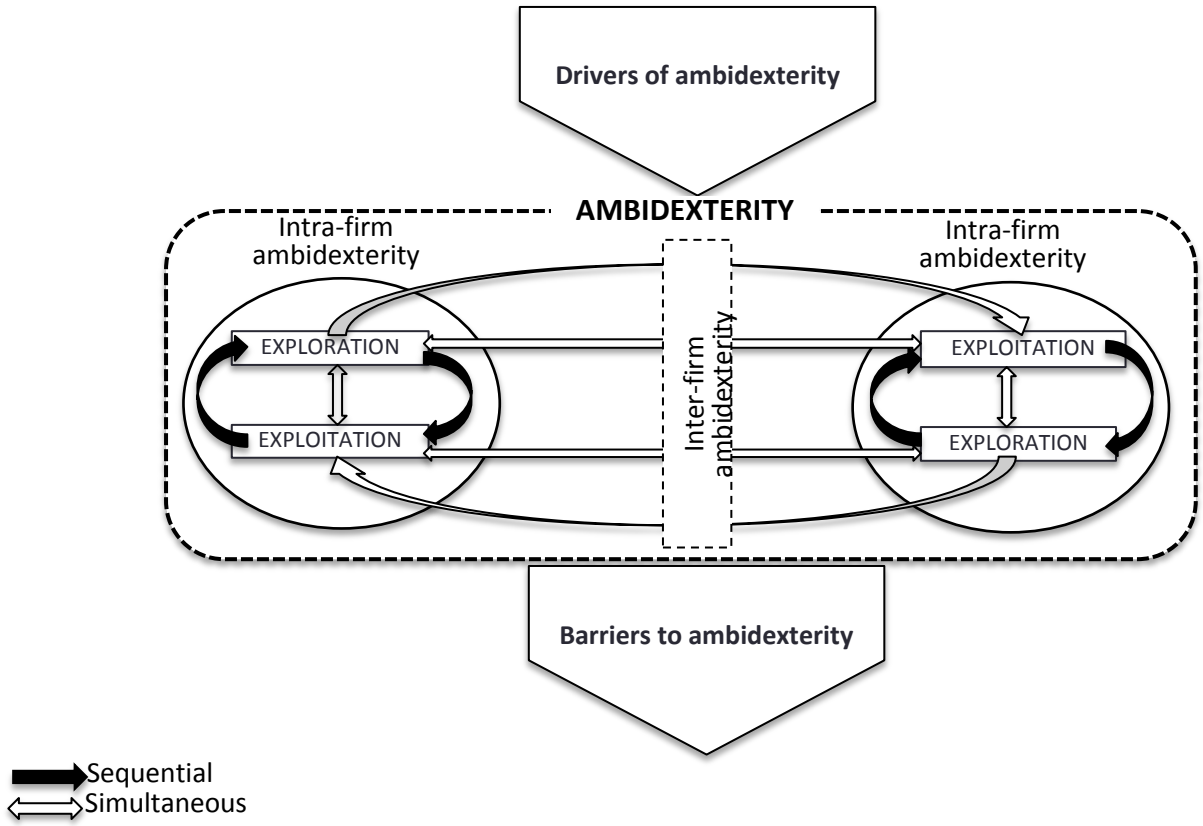

Figure 3. A typology of organisational ambidexterity in high-tech SMEs