

Choice of Structure, Business Model, and Portfolio: Organisational models of Knowledge Transfer Offices in British Universities

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Abstract

This paper addresses the gap in the knowledge transfer literature around how universities choose specific organisational models for their knowledge transfer offices (KTOs). Organisation theory points towards strong interlinkages between strategy, structure, and processes in organisations. This motivates an exploration of similar links within the organisational setup of KTOs. In doing so, the paper provides a unified theoretical framework around a university's choice of structure, business model and strategic preferences for their KTOs linked to university specific contextual factors. A qualitative approach is used wherein four very distinct British universities are examined as individual case studies. We find that strategic aims of the university around practitioner engagement, the quantity of applied research and research specialisation are key factors in determining the organisational characteristics of the KTO. The theoretical framework derived from the cases makes two key contributions to the university knowledge transfer literature. First, it links the university level contextual factors to the local model of knowledge transfer. Second, it allows us to develop a set of generic models of knowledge transfer which can potentially guide universities to develop their own specific models.

Keywords research commercialisation, knowledge transfer, knowledge transfer office, academic engagement, higher education

1. Introduction

University research and its subsequent impact on industry have been the focus of discussion in both academic and policy making circles for a long time (Acs et.al., 1992; Berman, 1990; Lee and Bozeman, 2005). Universities are no longer considered to be just “ivory towers”, solely for the creation of new knowledge and education, but are increasingly viewed as key players in the process of dissemination of this knowledge in forms useful to practitioners (Thursby and Thursby, 2002). Universities are increasingly considered to be “entrepreneurial” (Etzkowitz et. al., 2000; Guerrero and Urbano, 2012; Guerrero et.al., 2016), and are seen to play a key role in driving entrepreneurship alongside innovation (Guerrero and Urbano, 2014). This connection between the traditional knowledge creation function with the more recent knowledge exploitation function, often labelled as “knowledge transfer” (KT), has encouraged a growing body of literature examining its antecedents, impacts, role, motivation, and engagement of key players (researchers, firms, universities etc.). In contrast, relatively less attention has been paid to the *organisational* aspects of KT, the locally implemented framework within which it is carried out, and the choice made about various aspects this framework by university managers and the KTO’s relationship to researchers (Huyghe et.al., 2016; Perkmann et.al., 2013).

Universities as organisations, have evolved in their entrepreneurial outlook and developed relevant internal processes to support their increasingly important KT activities (Ambos et.al., 2008; Phan and Siegel, 2006). Generally, such activities have been funnelled through dedicated administrative units linked to the university, acting as a conduit between university researchers and the external world. These administrative units, often referred to as the *Knowledge Transfer Office* (KTO) have grown in importance and are increasingly seen as a crucial ingredient within the KT process of any university (Huyghe et.al., 2016; Siegel et.al., 2007).

Prior research examined the link between knowledge transfer (KT) outcomes and KTOs from various perspectives, such as researchers’ incentives (Link and Siegel, 2005; Lach and Schankerman, 2004), managerial incentives (Belenzon and Schankerman, 2009) and efficiency of KTOs (Chapple et.al., 2005). However, systematic studies on KTOs themselves, their organisational characteristics, scope, and role, are fewer and significantly narrower in focus (mostly limited to policies on managing disclosures, patenting, licensing and spin out activities). At the same time, these studies have viewed KTOs from a unidirectional perspective, where given characteristics of a KTO are examined for impact on specific outcomes (for researchers, universities, industries, or the economy). It has however been established that KTOs are also willing to explore new models and paradigms of knowledge transfer (Martin, 2012; Sharifi et.al., 2013), and the changes they themselves undergo should not be overlooked.

KTOs do not function in isolation from the rest of the university and are governed by the same overarching principles and strategies of the parent organization. Hence it is expected that the KT processes, the KTO’s structure, its preferred modes of interaction, and its relationship with the rest of

the organisation will be conditioned by the university's own context, history, and characteristics. In fact, KTOs *coevolve* with the parent organisation over time, i.e. changes to the university are reflected on the KTO as well. This in turn has implications on the impact generation and entrepreneurial processes being channelized through the KTO, thus modifying the knowledge transfer interface (Lockett et.al., 2015).

It is well established that entrepreneurial universities need to embrace the need for change in response to the emerging external business environment (Siegel and Wright, 2015; Siegel et.al., 2007). The need for a university to have a dynamic and entrepreneurial outlook is increasingly seen as crucial, given that the overall economic climate is in a constant state of flux in recent years (Etzkowitz et.al., 2000; Guerrero et.al., 2016; Miller et.al., 2014). KTOs play the role of a coordinator, champion and the "institutional entrepreneur" in the KT process (Siegel et.al., 2007), and hence the overarching changes in the university are mirrored on them (Sharifi et.al., 2013).

This paper examines how organizational characteristics of KTOs are shaped by the local contextual characteristics of the university they are situated in. It explores the links between the university context, particularly organisational strategy and nature of research carried with how its KTO is structured and managed. Taking an inductive approach, this study extends the theoretical understanding of how universities and their KTOs shape a local model of knowledge transfer, based on their specific needs. This is supported through a set of qualitative case studies, which explore a set of specific models of KT in the UK and their linkages with university specific factors.

Organisational literature has indicated that interlinkages exist between overall strategy and structure (Cummings and Worley, 2015) and that centralisation, specialisation, and differentiation are key factors behind the success of innovative organisations (Damanpour, 1991; Wolfe, 1994). This leads us to focus on three aspects of a KTO's activities within an entrepreneurial university. First is its *structure*, i.e. the nature of its relationship with internal stakeholders within the university. That structure of a KTO is crucial in determining KT outcomes has been established (Bercovitz et.al., 2001), but how structure itself is determined within the context of the university, is yet unexplored (Perkmann et.al., 2013). Second is its *business model*, i.e. its relationship with the external stakeholders such as intermediaries and specialists who provide specific support for KT. The role of intermediaries in innovation and KT has been recognized in the literature, little attention has been paid on antecedents of these relationships (Hayter, 2016; Howells, 2006; Wright et.al., 2008; Yusuf, 2008). Thirdly, we examine a KTO's *strategic preferences* over multitude of KT pathways and how these preferences are determined at the organisational level. Our study develops a unified theoretical framework, providing a mechanism to explain a university's choices along these dimensions.

The results reveal clear links between the context and the university's choice of its KT framework, which are presented in a set of propositions mapping university level characteristics to the KTO's

organizational features. A set of generic KT frameworks are derived which can act as a template for universities to implement or adapt, based on local needs. These findings are of relevance university managers looking to explore new models of KT or improve the current ones. They are also interesting from a policy perspective, as they address the issue of heterogeneity among universities, both in terms of performance as well as internal organisational models.

The rest of the paper is organised as follows. In Section 2, we provide the background and motivation of our research in terms of the extant literature and its gaps. In Section 3, we describe the methodology adopted in our analysis. This is followed by the main findings in Section 4. Section 5 discusses these findings, puts forward the propositions and the resulting theoretical implications and the paper concludes in Section 6. The Supplementary Material provided with alongside this paper carries detailed discussion of the data used here and further analysis.

2. Background

While prior studies have focussed on one or more antecedents of KT, the literature lacks a unified theoretical framework incorporating organizational and institutional factors affecting the local model of KT in universities (Perkmann et.al., 2013). There is little theoretical guidance on how a university chooses among the alternative channels of RC and AE, how a KTO organisationally adapts itself in response to such choices, and what internal processes are put in place in order to support KT through these channels. This absence in the extant literature, particularly the organizational aspects of KTOs, is proving to be critical for two important reasons.

First, universities operate within an external environment which has become increasingly competitive and constrained (Siegel and Wright, 2015; Miller et.al., 2014). Engaging with industry is no longer restricted to a handful of universities, but is increasingly treated as important by all. Locket et.al. (2015) comprehensively argue that “third stream” activities have become institutionalised in universities in response to changes in the external environment. At the same time, universities have become increasingly entrepreneurial and have started to play a key role in developing an entrepreneurial outlook and culture (Etzkowitz et. al., 2000; Guerrero and Urbano, 2012; Guerrero et.al., 2016). Secondly, as universities have become more entrepreneurial, models of KT have undergone radical changes in recent years (Etzkowitz et.al., 2000; Miller et.al., 2014). KTOs have not remained as static entities and have used “learning processes” to adapt their relationships with external partners given a changing external environment (Weckowska, 2015). KTOs have had to adapt with respect to the university’s changing internal environment as well, to establish their own unique identity (O’Kane et.al., 2015).

It is well established that organisations restructure and reorient their processes, reflecting changes in strategy and tactics (Miles et.al., 1978; Cummings and Worley, 2015). Universities have had to adapt strategically to the changing external environment and as their third-stream activities have gained in importance and focus (Siegel et.al., 2003; Slaughter and Leslie, 1997; Hewitt-Dundas, 2012). Starting

from investments into parallel strands of activities and infrastructure (Ambos et.al., 2008), to managerial and academic incentives for KT (Link and Siegel, 2005; Lach and Schankerman, 2004; Belenzon and Schankerman, 2009), to how universities react to institutional changes reflecting the growing importance of research impact (Martin, 2012), strategic motives have been key in driving organisational changes around KT. Hence an examination of how a KTO's internal structure is adapted in response to strategic and tactical considerations of the university is critical in understanding its KT model.

Structural aspects of a KTO concentrates on the internal relationships and mechanisms of the KT model in a university, primarily on how the KTO interacts with researchers, departments, and Schools. However, a KTO is an outward facing organisation with the remit of facilitating links between university's research and its potential end users. Maintaining an external orientation by building up networks of external stakeholders is a critical component in any entrepreneurial venture, and the KTO is no exception (Brettel et.al., 2014). The role of knowledge intermediaries, who can be used as a conduit between the university based KTO and industry based clients, has become increasingly important (Hayter, 2016, Wright et.al., 2008). The nature of these external relationships has impacted the overall "business model" of KTOs themselves as well as their day to day operations.

Alongside internal and external relationships of KTOs, there has been a sector wide shift in the various modes of interaction with industry, with the AE channels increasingly becoming the dominant mode of KT (Perkmann et.al., 2011), and this reflects a major paradigm shift in the way KTOs function. The IP centric RC route and institutional setup was based on the premise of a *unidirectional* flow of knowledge and technology from universities to industry, mediated by the KTOs (Geuna and Rossi, 2011). However, the AE channels encourage a *bi-directional* flow of knowledge, where university researchers and external users of research are both involved in the knowledge creation process (Bekkers and Bodas Freitas, 2008; Perkmann and Walsh, 2007). From being narrowly focused administrative units dealing with RC only, KTOs have increasingly adopted a multitude of pathways (Perkmann et.al., 2013) and are seen to deal with a large portfolio of contracts and contract types.

Appropriate structure, business model and strategic preference over channels are some of the key organisational aspects of a KTO, enabling it to respond optimally to demand and the changes in the environment. We now discuss each of these aspects in further detail.

2.1 Internal Relationships: Structure

Organisational theory has explored the role of structure in the evolution of the modern enterprise (Chandler, 1962; Axater, 1982). The choice of a centralised versus decentralised structure has implications on how teams function and interact, and how critical organisational processes are incorporated (Chen, 2007). KTOs themselves are organisational sub-units within universities with their own mandate, dedicated manpower and with a reasonable degree of autonomy. The "customers" of the

KTO include the rest of the university staff, including academic researchers, research related administrative personnel etc., as well as external stakeholders. The question that arises naturally is, what is the ideal structure for a KTO, given its local circumstances? And how does this structure evolve, based on changing local circumstances.

Organisational strategy and structure have been established as being highly interdependent and are viewed as complementary factors for success (Miller, 1987). There is evidence to show that organisations involved with knowledge management may prefer more devolved structures from a strategic perspective (Hedlund, 1994). Hence it is important to understand how a KTO will structure itself within the larger more complex organisation, that is the university.

These questions have only been partially addressed in the literature. Bercovitz et.al. (2001) examined the structure of three independent KTOs in the US, and compared the model in each along the dimensions of information processing capacity, coordination capability and incentive alignment. They juxtaposed the observed models on four alternative theoretical structures proposed in Chandler (1962) and Williamson (1975, 1985): the U-Form or a centralised unitary structure; the M-Form or a centralised but disaggregated structure; the H-Form or a decentralised and disaggregated structure; and finally, the MX-Form or a matrix structure. Bercovitz et.al. (2001) postulate that these alternative structures have different impact on functioning and efficiency of the KTOs and use the data from the three organizations to show that their underlying structures do have an impact on overall levels of knowledge transfer. The structure of each university was treated as an *independent* variable in the analysis, with the focus around its impact on the three dimensions mentioned above.

While Bercovitz et.al. (2001) provides the starting point of examining the relationship between the structure of a KTO and university level KT outcomes, treating “organizational structure” as an exogenous variable misses the complexity and evolving nature of a KTO with respect to the history, context and external pressures faced by universities. Debackere and Veugelers (2005) study several universities and emphasize the role of “decentralisation” in KTO structures, in order to better capture the variety of research within the organisation. But previous research has not addressed the question of *why* certain KTOs adopt a centralised structure and why certain others don’t. This paper aims to address this gap, by examining how a KTO’s structure can be determined by local university related contextual factors.

2.2 External Relationships: Business model

A key criterion underpinning an entrepreneurial organisation’s success is its business model (Morris et.al., 2005). The business model is shaped not just through its internal processes, but through its relationship with external stakeholders as well. “Outsourcing” of key internal functions and processes is increasingly seen as an important component of business models. It has been argued that outsourcing leads to efficiency gains through overall cost reductions and the access to specialist knowledge and

capabilities. Outsourcing as a business model is well established in industry, typically in relation to information systems, services, and back office functions. While the benefits and costs of implementing a model based on outsourcing has been debated (Lee and Kim, 1999; Belcourt, 2006), it has been shown to improve efficiency for knowledge and IP based services (Quinn, 1999).

KTOs have increasingly adapted an external outlook using knowledge intermediaries and specialists to carry out some of its core functions (Hayter, 2016, Wright et.al., 2008). This is one key aspect of KTO's operations which has largely been overlooked in the extant literature, but which is becoming extremely relevant (Yusuf, 2008). Such intermediaries are usually specialists in certain areas, ranging from patent attorneys to technology scouting to financing, and increasingly to specialist companies undertaking multiple aspects of RC and AE on behalf of the university.

With institutional and policy changes altering the pressures on universities and academic researchers to demonstrate impact of their research more explicitly (Lee, 1998; Mowery and Sampat, 2005; Haeussler and Colyvas, 2011), KTOs may expect to manage increasingly greater volumes of potentially applicable research outputs, greater volumes of contracts in the future. Hence outsourcing of key operations to external stakeholders is a business model which can no longer be ignored by KTOs. In this paper we explore whether this outsourcing decision in turn relates to context and organizational characteristics of the university itself.

2.3 Strategic preferences: Portfolio

Knowledge transfer from universities is not a homogenous phenomenon but takes multiple forms, and maybe carried out through number of alternative pathways (Hewitt-Dundas, 2012; Rossi and Rosli, 2015). In a comprehensive review of the literature, Perkmann et.al. (2013) categorises them into two independent streams – Research Commercialisation and Academic Engagement (Figure 1).

Research Commercialisation (RC) encompasses strategies used to commercially exploit intellectual property generated through market mechanisms, involving patenting, licensing, spin outs and related entrepreneurial activities. Research on KT had largely focussed on RC activities (Siegel et.al., 2003; Siegel et.al., 2007; Siegel and Wright, 2015), since KTOs mushroomed largely in response to intellectual property legislations in many countries aiming at providing an institutional framework through which universities could patent and license their research (Mowery et.al, 2004, Mowery and Sampat, 2005; Wright et.al., 2007).

It has however been established that universities have looked well beyond the market driven RC routes in creating impact through knowledge transfer (Geuna and Rossi, 2011; Perkman et.al., 2013; Rossi and Rosli, 2015; Locket et.al., 2015). At least as far as the UK is concerned, these occupy a much larger proportion in terms of volume and value compared to the IP route. The most prominent of these alternative channels are: contract research, collaborative research, and consultancy, which are clubbed

together under Academic Engagement (AE).¹ AE channels largely involve “knowledge related collaborations by academic researchers with non-academic organisations” (Perkmann, et.al., 2013), rather than a clearly defined market mechanism, as seen in RC.

We adopt the terminologies of RC and AE to refer to the alternative modes of KT for the rest of the paper. This makes a clear distinction between the more collaborative AE routes involving some element of knowledge co-creation with partners versus the market oriented RC routes indicating “sale” of technology and knowhow.

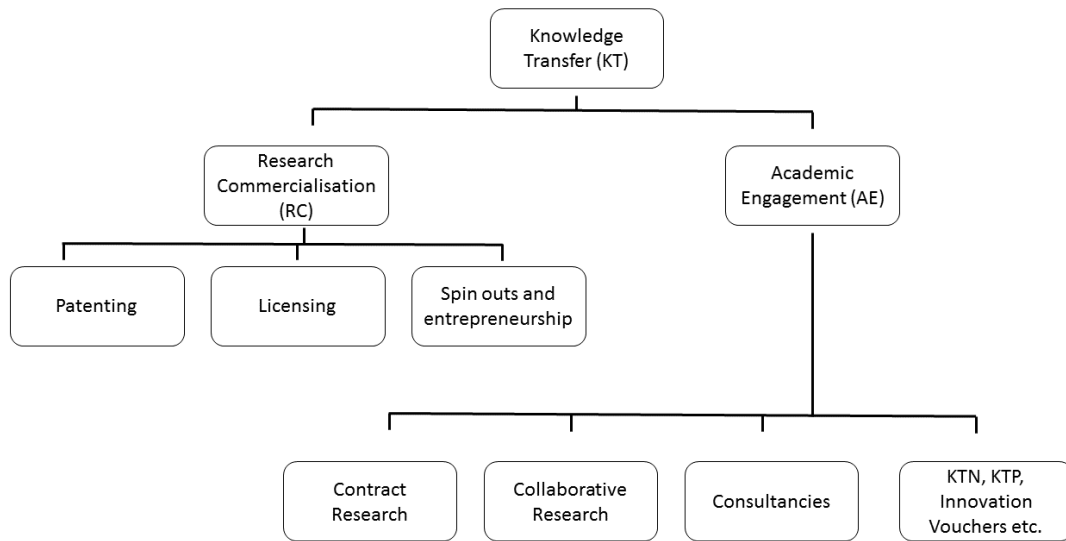


Figure 1: Categorisation of Knowledge Transfer from universities

The third organisational aspect examined here is the university’s preference over alternative KT mechanisms. Universities have increasingly become more strategic in their approach to industry engagement in general and commercialisation in particular (Siegel et.al., 2007; Lockett et.al., 2015; Siegel and Wright, 2015). For example, AE channels, specifically contracts and collaborations are increasingly the dominant channels, and universities seem have responded to the non-profitability of the patent/licensing model (Perkmann et.al., 2013; D’Este and Perkmann, 2011). In a Europe wide study however, Geuna and Nesta (2006) find that patenting in universities seem to be on the rise, although it remains heterogeneous across institutions and disciplines. They also find that licensing is largely not

¹ In UK universities, IP related income accounted for 2-3% of total income coming to the sector between 2003-04 and 2012-13. Contract research accounted for 32% followed by collaborative research (25%) and consultancies (11%). Other, such as Continued Professional Development (CPD), Continued Education (CE), Facilities and Equipment lease etc. accounted for the rest (Source: HE-BCI Report 2014).

profitable for universities. However, what is not well understood is the following: Do KTOs prefer or prioritise any specific channels, and if so, exactly what determines the priority ordering?

While the trends in RC are relatively straight forward to evaluate, given the well-structured data available on patents, patent citations, spin out formation and to a lesser extent, on licensing deals, evaluating AE channels may be difficult given the absence of a market mechanism. While survey data from universities do provide overall volume and value figures relating to specific AE routes, it does not reveal strategic priorities and preferences of the KTOs themselves.² However, with growing evidence that external partners consider AE routes more valuable than RC (Cohen et.al., 2002, Perkmann et.al., 2011), understanding the choices made by KTOs at an organisational level becomes critical.

2.4 Conceptual Framework

Our paper links these key organisational characteristics to the local context of a university within a unified theoretical framework. Unlike Bercovitz et.al. (2001), these are treated as *endogenous*, implying that the KT framework are determined by local factors and are not considered as given. As discussed above, the importance of these three characteristics in defining a KTOs identity is well established in the KT literature. In fact, organisational literature also points toward centralisation, specialisation, and differentiation (Damanpour, 1991; Wolfe, 1994) as key determinants of the innovative behaviour in organisations. These can be linked directly to the organisational characteristics of KTOs being discussed here – namely, structure, business model and preference, and hence forms the basis of the theoretical contribution being made here in relation to entrepreneurial universities.

The extant literature has established several contextual factors which could impact a university's choices about how KT is organised and its performance. Primary among these are quality, quantity, and breadth of research output of the university (Sengupta and Ray, 2015; Hewitt-Dundas, 2012; Perkmann and Walsh, 2009; D'Este and Patel, 2007). Additional key factors discussed in previous literature are the nature of incentives for staff (Siegel et.al., 2003; Link and Siegel, 2005; Belenzon and Schankerman, 2009), and university level heterogeneity indicated through age, location, size, and nature of links with industry (Azagra-Caro et.al., 2006; D'Este and Patel, 2007; Ponomariov and Boardman, 2008). Our study does not ignore these, rather directly incorporates them within the contextual background of the university. While previous literature has linked these with KT *performance*, in this paper we examine their effect on the KT *framework*.

However, it is difficult to examine any KT framework divorced from KT performance. It is likely that there is a medium to long term link between framework and performance in entrepreneurial universities,

² In the case of the UK, the HE-BCI survey questionnaires (Part A) do contain information about strategic directions etc., but the questionnaire is largely focussed on the *use* of innovation funds that universities receive from public sources. Preferences about KT routes are not explicitly asked, and seldom addressed.

as is seen in entrepreneurial firms (Cosh et.al., 2012). Hence, we consider performance as a part of the context which influences the locally implement KT model.

The role of overall university strategy with regard to research and KT is under examination in the literature. It is increasingly being recognized that universities may involve in KT through multiple pathways, involving multiple disciplines (Hughes and Kitson, 2012; Rossi and Rosli, 2015). Deiacco et.al. (2012) point out that they are also required to respond strategically to external pressures of funding, policy changes and changes in the entrepreneurial climate. As an organisation, top level strategic changes will impact on its internal practises and processes, including the KTO – and hence is included in our model as a contextual factor as well .

The overall conceptual framework underlying this study is presented in Figure 2. The local context of the university, incorporating research, strategy, KT performance, incentive structures and overall reputation drives the local KT model. Three aspects of the model – namely, structure, business model and strategic preferences over are examined, and the model maps the contextual factors on these aspects of the KT model.

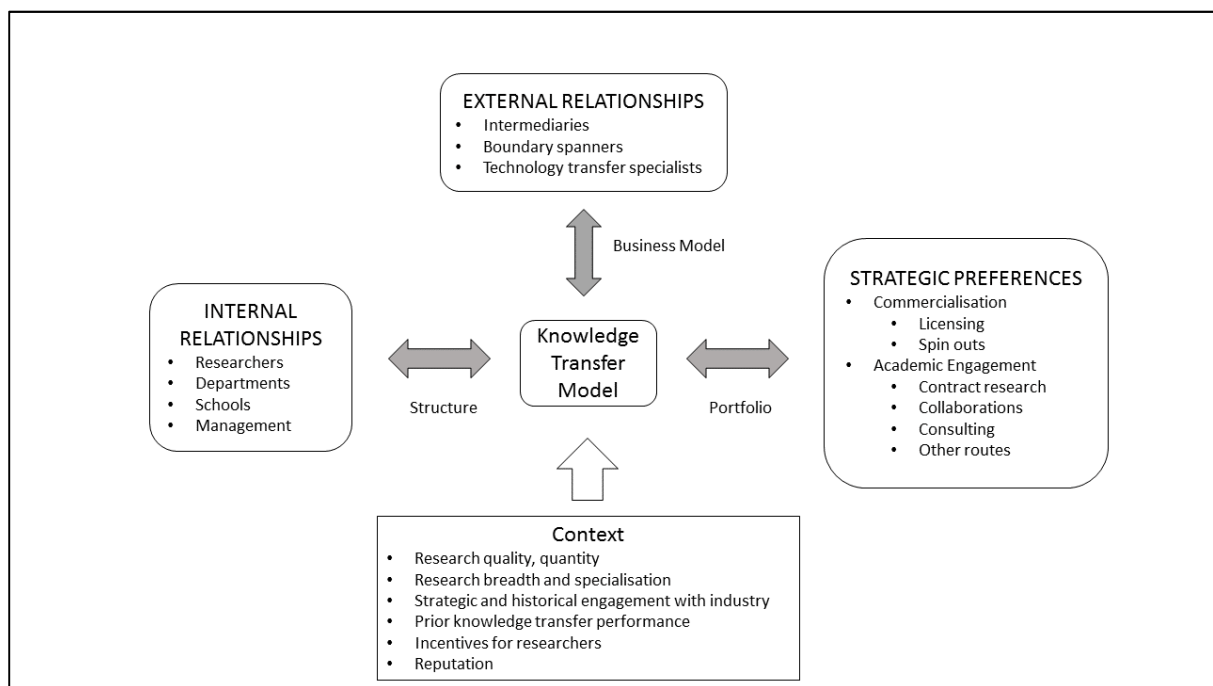


Figure 2: The conceptual framework linking university level contextual factors to the model of KT.

3. Methodology

Our study adopts a case study approach to examine the impact of context on the KT framework of a university within the British HE sector. This approach provided us with the flexibility to interrogate the models adopted in each of the cases thoroughly, considering the context of the university. Given the

absence of existing holistic models of knowledge transfer framework in the extant literature, these cases allowed us to develop a set of propositions connecting a university's characteristics to its adopted KT framework.

Gibbert et.al. (2008) and Eisenhardt and Graebner (2007) emphasize that *sampling* of the appropriate cases is a key step in developing a robust case study. Given the central research questions, we wanted to consider cases which not only pointed toward significant differences in the underlying KT models themselves, but also universities whose local contexts varied significantly from each other. The UK Higher Education Statistical Agency (HESA) makes available very detailed university level data on many aspects of universities in the UK, including research outputs and knowledge transfer. We carried out a clustering analysis to classify all degree awarding universities in the UK on performance along the three dimensions of research commercialisation, academic engagement, and research related activities.³ A set of candidate universities were selected to ensure a good spread across the clusters in all three areas. Finally, given the availability and willingness of respondents, four universities were selected for this study, and these were universities of Oxford, Durham, Essex and Cranfield.

Oxford and Durham are Russell Group universities, with a very long history, a wide research base and of relatively large scale. On the other hand, both Cranfield and Essex are relatively newer universities with a significantly narrower focus in research and are of a small scale than Oxford or Durham. Cranfield is a post-graduate university with "research and development portfolio solely focused on technology and management". Essex on the other hand has a strong research base in the social sciences and humanities. Quantitative data (HE-BCI surveys) from the UK Higher Education sector reveals that all four universities vary significantly in the overall performance in KT related activities (Figure 3).

Given the key role that local context plays in this research, we adopted the qualitative approach in our research methodology. We gathered primary data through in-depth interviews of key senior KTO personnel and academic researchers in each of the universities using semi-structured questionnaires. A semi-structured approach was preferred given the variation in the organization and culture of the KTOs and the universities. This approach gave us the flexibility to probe into the local KT models as needed and examine their strengths and weaknesses. The list of guiding questions, which formed the underlying basis of the interviews for both KTO management and researchers, can be found in the Supplementary Material.

In terms of the interviewees, the key point of contact was the Director (or equivalent) of each of the KTOs. Each was interviewed over two to three sessions, a session lasting between 1 to 2 hours. Additional senior managerial personnel were also approached for more information on recommendations of the Director. Moreover, selected faculty members who have undertaken

³ The results of the clustering analysis and the relevant methodology is presented in the Supplementary Material accompanying this article.

knowledge transfer within the current organisational setup were also approached with a separate questionnaire for their feedback on the whole process and experience. In all 16 individuals were interviewed across the four universities between April 2013 and December 2013, either in-person or over telephone.

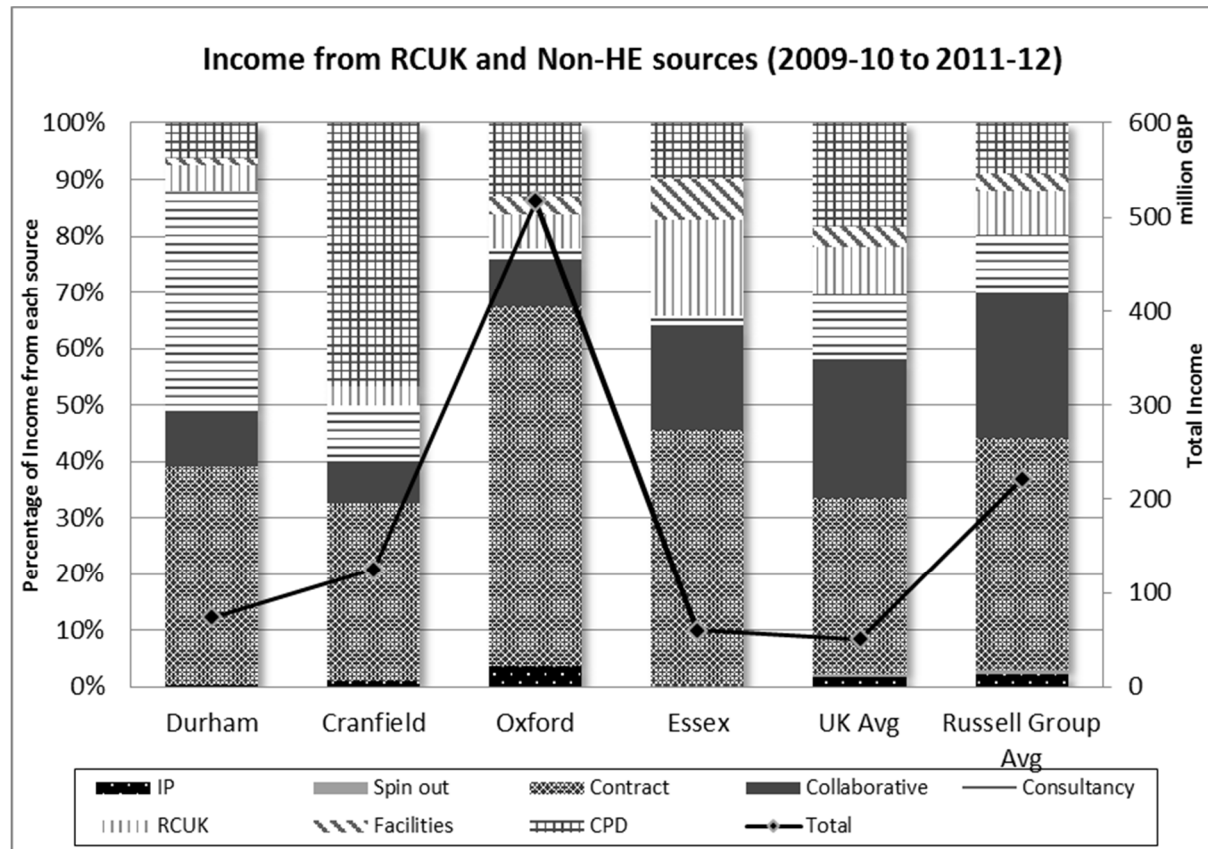


Figure 3: Income from research councils and non-HE sources (2009-10 to 2011-12), total and percentages. Excludes research income from EU and other funding bodies.

All interviews were transcribed and then coded over multiple rounds. The coding exercise was designed to reveal both contextual features of the universities as well as the characteristics of the locally implemented KT model. The coding revealed two complementary sets of dominant themes, which formed the basis of subsequent analysis. Table 1 provides a taxonomy of the themes used in the analysis, and Table 2 presents a set of examples of the themes and their relation to the transcribed data.

The first set consisted of a collection of *emerging* themes, which were labelled as: *strategy*, *tactics*, *external orientation*, and *performance*. These themes revealed insights into the local context around each case. We label them as “emerging”, as the interview questions did not probe directly for these, but arose spontaneously from the coding exercise. The second set of themes consisted of a collection of *descriptive* themes, which represented descriptions of the locally implemented KT model. These themes were chosen by the authors and explored actively through the questionnaire. These are labelled as:

structure, model, preference, scale, change, operations, and research. Based on this thematic exercise, each case was analysed for their locally implemented KT framework and context.

4. Findings

The four universities chosen for the cases studies are characteristically very different from each other, both in the KT model they have adopted as well as in the context they operate in. Here we present a comparison of these universities based on the three organisational characteristics, with the help of the thematic analysis of the primary data. Tables 3 to 6 present the detailed thematic analyses of all the cases based on the two sets of themes – emergent and descriptive. Table 7 summarises each of the cases with respect to research, the locally implemented KT framework and performance across RC and AE channels. The accompanying Supplementary Material contains a more detailed description of each case, although all salient points can be found in the discussions below.

4.1 Structure

The IP management and KT setup in Oxford is organised under two parallel strands: Research Services, an organizational sub-unit of the university responsible for the bulk of AE; and Oxford University Innovation (OUI), a wholly owned but external subsidiary of the University responsible for the bulk of RC.⁴ *Structurally*, the KTO's activities are mostly centrally managed, but management of spin outs and entrepreneurship have been devolved to the departments.

For Durham, the Durham Business & Innovation Services (DBIS), an office within the university, plays the role of a gatekeeper to all of university's KT activities. *Structurally*, Durham has adopted a centralised model for its KTO, except for contract research, which is mostly channelized through departments and research centres directly. DBIS has a wide remit in terms of providing KT support and increasingly plays an *anchor* role in cross departmental research collaborations as well.

Essex is similar to DU in this respect, as the Research and Enterprise Office (REO) undertakes the role of a KTO, is centrally managed, with dedicated personnel looking after all its Faculties.

Cranfield is split into five Schools, each of which are treated as *independent businesses*, and each has its own responsibility of generating research income and ensuring financial viability. Consequently, they are divested with a lot of autonomy regarding the choice of KT strategies. *Structurally*, it follows a fully *decentralised* approach where most key functions of a KTO are devolved to Schools, faculties and departments within the university. These units are incentivised accordingly for carrying out AE activities. The faculty members are also incentivised directly, so that technology transfer is an important factor within their research and career considerations.

⁴ Till mid-2016, and at the time of the data collection, OUI was known by the name of ISIS Innovation.

4.2 Business model

The business model observed in Oxford's KT framework shows a clear division in roles between those organizational units internal to the university and those external to it. The patenting and licensing aspects of RC and consulting in AE, have been outsourced to OUI. Contracts and collaborations on the other hand, are managed in-house by Research Services and within the faculties and departments themselves. The case of Cranfield is somewhat similar in that, most of RC management has been outsourced (to OUI) while management of AE activities are located internally, but devolved into the Schools and departments.

For Durham on the other hand, all KT functions are located wholly internally to the university, with both RC and AE management brought within DBIS following re-evaluation and restructuring in 2008. Similarly, all key operations in Essex have been located internally with the REO.

4.3 Portfolio

As part of its portfolio preference, Oxford explicitly states that all RC and AE channels are equally important strategically. As opposed to this stated preference, actual performance reveals that contract research accounts for the bulk of income followed by collaborations. However, as can be seen in Figure 3, Oxford is one of the few universities in the UK to have seen success in RC as well as in AE, in line with its strategic intents.

In case of Durham, the stated preference is for collaborative research, especially those which can be brought under overarching umbrella agreements with commercial partners, encompassing multiple independent KT projects. Durham has consciously moved away from a dominant RC centric model in the past, and although currently contracts and consultancies account for most of the income from KT activities currently, it is in the area of long term multiparty collaborative research initiatives that DBIS wants to invest its resources in.

In Cranfield, it is the AE channels – primarily contract research – is seen to play the most important role, and this is reflected in actual income figures as well. The RC route is followed highly selectively, and with early return on investment being the guiding principle in every case.

Finally, in case of Essex, the REO states that it is willing to explore all channels of AE (contracts, collaborations, consultancies and alternative routes such as KTPs), but places little emphasis on RC routes. This has been reflected in its performance in recent years, with growth in contracts, collaborations and the KTP route.

4.4 Context and implications

While the distinction and similarities between the local models have been discussed above, evaluating the context becomes necessary to understand the background and evolution of these models. We discuss each university in turn.

For Oxford, the primary feature of the university is the extremely large volume and width of research output, both applied and fundamental in nature. This is backed by its reputation for high quality across the board and a distinguished history of path breaking research. At the same time, KT and research impact is one of Oxford's strategic objectives. As the above discussion shows (see Table 3), Oxford has adopted a partially outward facing but mostly centralised model, where a degree of outsourcing combined with internal devolution is the main feature. The volume and quality of research probably makes the outsourcing model a *necessary* ingredient in its KT setup. At the same time, these characteristics of Oxford's research enable the external partnership with OUI to be sustainable and successful.

Table 4 provides the thematic analysis for Durham. Like Oxford, Durham is a Russell group university with a wide broad research base, with a focus largely on fundamental research. The analysis also reveals that DBIS has been involved in a few highly successful collaborative ventures in the past, involving several independent projects within umbrella agreements. Such agreements had materialised after sustained contact and dialogue between the partner organizations at multiple levels. Resources were invested by all concerned to sustain them in the long run. Effort was put in to redirect some of the in-house research to be relevant for the collaborators, often involving multi-disciplinary research centres and teams, which DBIS helped to organize. DBIS went through a period of restructuring and realignment in 2008, following an introspective exercise carried out by the university regarding its KT performance, ambitions, and strategies.

For such collaborative umbrella agreements to be successful, the benefits of long term collaborations must be apparent to all parties from the beginning. Moreover, contact between the participating organizations need to be at multiple levels and should be sustainable irrespective of turnover of people. Also, the KTO must be well connected with different departments and be aware of on-going research projects and their potential.

Table 5 provides the thematic analysis on the data obtained from Cranfield and illustrates its uniqueness in many respects. Cranfield has historically championed close links with business and industry, aiming to combine the rigour of academics and long-term thinking with the applied mind-set and problem solving focus of industry. It has close ties with industry from early on, with emphasis on science and engineering research throughout. Cranfield embodies the twin objectives of academic rigour and financial viability in their long-term strategy, and hence explicitly encourages researchers to be entrepreneurial. It is also a wholly post graduate university with a narrow research focus.

While the devolved approach minimises resource requirements for a centralised KTO, and allows for localised flexibility within departments, some additional criteria need to be fulfilled for its success. First, a well-designed set of incentives for individuals, departments and Schools are essential. Second, high level of awareness of KT opportunities, requirements and processes is needed. Finally, even if the

same overarching financially driven strategy is applied to all academic units across the university, it is essential that adjustments are made locally in Schools or departments, depending on the disciplines and research focus. For instance, the School of Business in Cranfield is very distinct from the other Schools in its focus, and hence a more flexible approach has been adopted.

Table 6 provides the thematic analysis for Essex. This is a relatively new institution compared to the others, especially well known for research in social sciences and in humanities, with a limited number of scientific departments. It differs significantly in character from both Oxford and Durham which offer a wide breadth of research across all disciplines, and from Cranfield, which has a strong engineering and technology focus. Despite limited focus on science and technology, Essex does have a positive record of KT, mostly attributable to AE in social science and humanities disciplines.

Given its relatively narrow research focus, both RC and AE had been a challenge for the university historically. Like most of the others in our study, Essex also has had to reorient its organisational policies on KT, towards using its strengths in social sciences and humanities. AE routes have been utilized to connect reasonably well with small to medium companies – who would have otherwise found it difficult to engage with universities. Essex’s preference for the AE route is understandable given its prominence in social science and humanities oriented research, where the distinction between what is truly “applied” versus “fundamental” can be blurred. In such cases, it is difficult for the research itself to find a ready home for use, or in other words for supply to create its own demand.

In such cases, KT needs to be more “demand driven”, and this is where the role of the REO becomes critical. The REO must be proactive in searching for possible avenues where such demand exists. In Essex’s case, researchers themselves provide assistance through personal contacts in industry wherever possible. However, barring a few exceptions, research in general is more oriented towards the fundamental variety, which may have resulted in a perceived gap between the functioning of the REO and the research activities within majority of the departments. There is a perception that the REO can be more proactive in bringing in business than has been the case in the past. And this is also where the REO can probably use networking initiatives such as the KTNs, business meetings etc. more effectively to “sell” the research output created in UE.

5. Discussion

Prior research focussing on the antecedents and impacts of RC and AE activities in universities has largely overlooked the organisational aspects of KTOs themselves. This has resulted in a gap in the literature, which given the structural shifts in the higher educational landscape, can no longer be ignored and which this paper begins to address. The findings presented here examine these organisational aspects and their potential determinants. We find that universities seem to have evolved very different

KT frameworks locally where contextual factors have played an important role. This implies that KTOs can be, and in fact need to be, organisationally heterogenous across the sector. Among the contextual factors, we find that strategic priorities of the university and the nature of research are central in influencing the organisational features of the KTO and its activities.

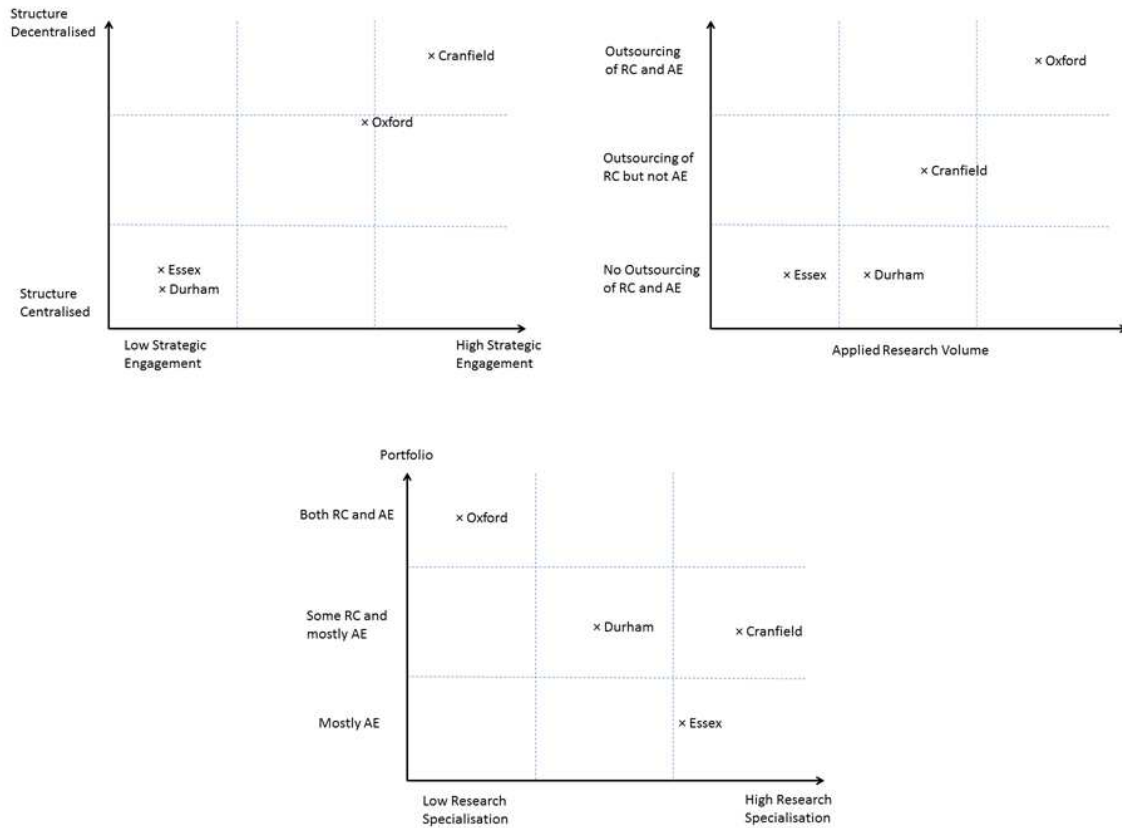


Figure 4: Mapping of case study universities in terms of (a) centralisation versus strategic engagement with users, (b) level of outsourcing vs applied research volume, (c) portfolio preference vs research specialisation.

The case studies highlight the importance of the nature (applied versus fundamental) of research, breadth (specialisation) of research and university level strategic priorities. Given that the analysis focussed on four key organisational characteristics of KTOs – structure, business model and portfolio preference, we now map out the relationships which emerged between these organisational characteristics and the key contextual factors. In Figure 4 we map out the key aspects of the KT model within the case studies and organisational research characteristics – (a) level of centralisation of KTO activities versus strategic engagement with end users of research, (b) level of outsourcing of core KT functions versus volume of applied research, and (c) channel specific performance versus research specialisation. The overarching differences in the local models, when juxtaposed against the differences in university level characteristics, reveal clear patterns which are stated in a set of propositions.

Proposition 1 (Structure): Universities which explicitly embody engagement with research users as part of their strategy are more inclined to devolve higher proportion of KT responsibilities to academic units, away from a centralised KTO.

Cranfield's and Oxford's models form the basis of Proposition 1 and links the strategic focus of the university with the underlying structure of the KTO (Figure 4a). This finding is in line with previous organisational literature, where the interplay between strategy and structure in an organisation has been stressed upon (Miller, 1987), especially in the context of knowledge management (Hedlund, 1994). It has been shown that the opportunities and incentives for KT varies across departments and research specialisations (Siegel et.al., 2007; Wright et.al., 2004). Hence it is only natural that universities more strategically focussed engaging practitioners would provide flexibility to academic units to shape their own KT framework according to discipline specific needs.

Proposition 2 (Business Model): Universities exhibiting relatively high volumes of application oriented research outputs are more inclined to outsource wholly or partly, its key KT functions to external organizations.

This is evidenced in the models adopted in both Oxford and Cranfield and their differences with those in Durham and Essex (Figure 4b). Given the scale of applied research in Oxford and Cranfield, it is tactically important for the KTO to outsource large portions of core functions to specialist intermediaries. As KT becomes more central to its core operations and as the volume of applied output increases in its research offering, it becomes necessary for a university to explore alternative business models to streamline operations and increase efficiency. The role of intermediaries, to whom key operations may be outsourced to reduce overheads and for access to specialist knowledge, becomes important in this scenario (Morris et.al., 2005).

Interestingly in the cases examined here, it is the RC functions which have been outsourced, while AE has largely been retained in-house – either centrally or devolved to the departments. Given the relatively poor performance of RC channels when compared to AE in the UK, it is likely universities are increasingly adopting a cautious approach to licensing and spin outs (Lockett et.al., 2015; Siegel and Wright, 2015) and outsourcing indicates a degree of diversification in risk. This highlights the importance of strategic responses of universities, especially in response to the changes in the higher education ecosystem (Martin, 2012).

This leads us to the next proposition, which links preference for RC and AE with research specialisation. It has already been established that the presence of more applied disciplines, such as engineering or bio-medicine increase the likelihood of KT (Bekkers and Bodas Freitas, 2008; Bozeman and Gaughan, 2007; Ponomariov, 2008). The following proposition generalises this further.

Proposition 3 (Portfolio): Preference for KT channels depends on the specialisation in their research. More specialised universities limited by the number of research active disciplines would prefer

channels involving AE, whereas those with a broader research focus discriminate between channels of RC or AE to a lesser degree.

While Bekkers and Bodas Freitas (2008) show the impact of specific disciplines on channel choice, our result hints at a more general effect of research specialisation. Both Cranfield and Essex are highly focussed in specialised fields of research, whereas Oxford is not. Both Cranfield and Essex have shown a strong preference for AE channels. Oxford on the other hand, states no special preference for any particular channel, and which is also reflected in its relatively superior performance in RC compared to universities in the UK. Durham falls somewhere in between, and has shown clear preference for the AE channel as well, although RC is carried out nevertheless (Figure 4c).

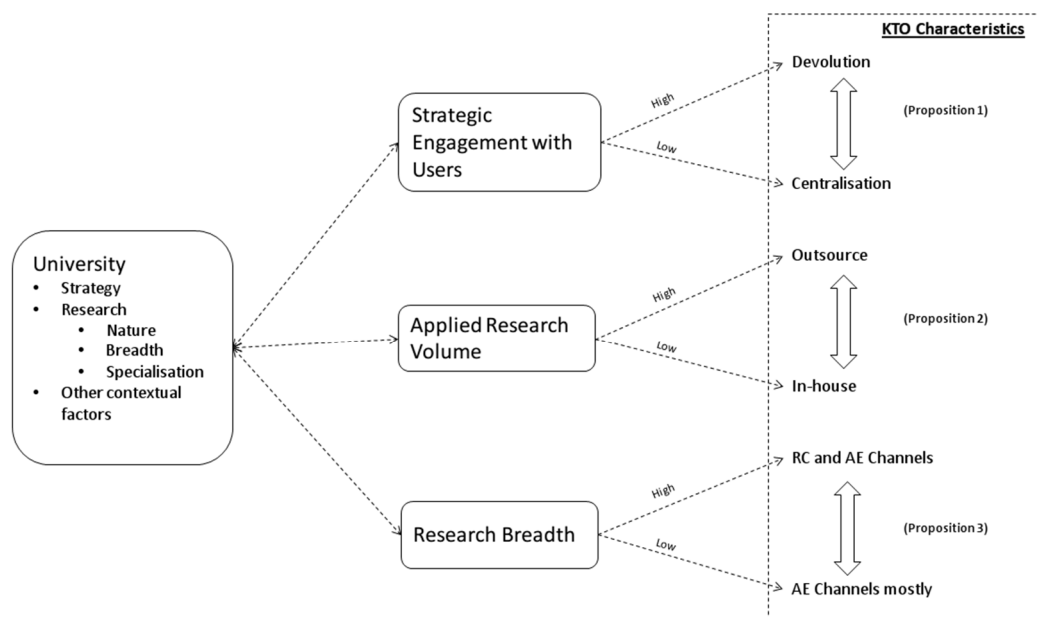


Figure 5: Findings – linking university level features with the KTO's characteristics.

These propositions form the basis of the first theoretical contribution of this paper, and is summarised in Figure 5. In Section 2 we presented the broad conceptual framework underpinning our analysis, and Figure 5 connects this framework to the overall findings presented in the propositions. What emerges is a pattern on how specific contextual factors affect specific key characteristics of the local KT model implemented in the university.

Our next contribution comes in the form of a set of generic KT models based on structure and business model. It is possible to abstract away from the contextual factors of the case studies and derive generic models of KT, based on the key characteristics examined here. These are shown in the four quadrants in Figure 6, where level of outsourcing of KT activities is presented along the X-axis and structure

devolution is presented along the Y-axis. Note that portfolio preference would ideally form the third dimension, and may be overlaid on Figure 6, to provide further variation to these models.

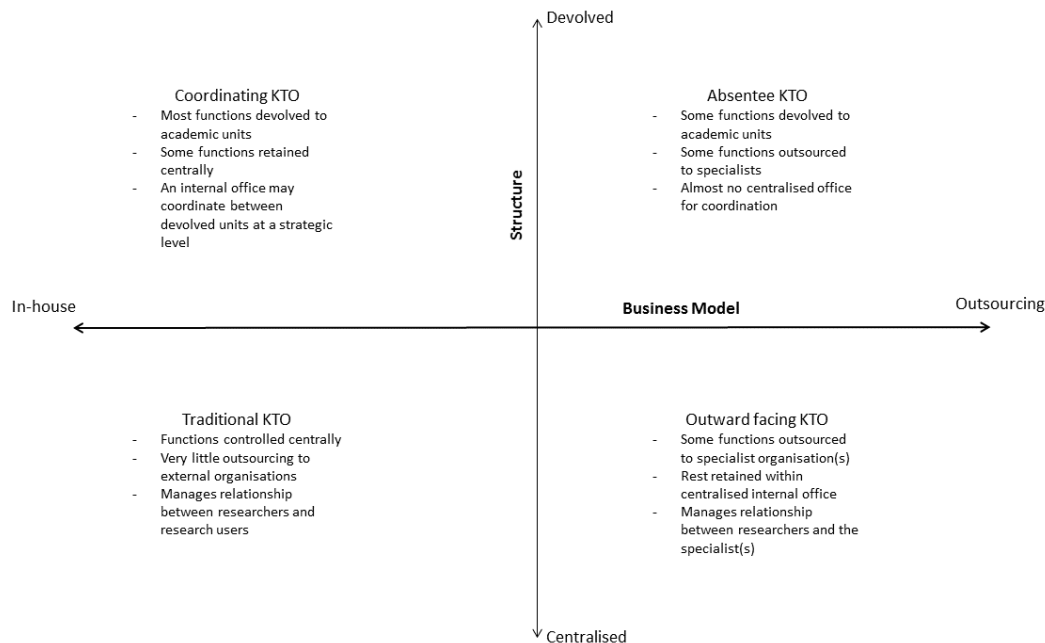


Figure 6: Generic models of KTO, based on structure and business model.

KTOs originally started out being specialised centralised offices within universities (Phan and Siegel, 2006) and in many cases, have retained this character (for instance in Essex). The *Traditional* model points towards this approach. As universities evolve, and incorporate practitioner engagement within their strategic portfolio, it makes sense for the KTOs to devolve more of their functions into departments – with the central office playing a *Coordinating* role, as has been implemented in some degrees in both Oxford and Durham. When scale effects of a large volume of applied research set in, it makes sense for the KTO to adopt an outsourcing model, which may be coupled with a devolved approach (*Absentee KTO*) or may retain some level of central control through an *Outward facing KTO*. The former is more of the characteristic of Cranfield, while the latter resembles what is found in Oxford.

Each model has its own benefits and costs, and further variation is possible along the portfolio dimension. The actual adoption of one by a university would depend largely on contextual factors local to the university. And KTOs may choose to move from one quadrant to another (and change channel preferences at the same time), given changes in the local context (Durham and Cranfield). It is also possible for the KTO to adopt a hybrid framework which combines two or more generic models (such as in Oxford).

6. Conclusion

This paper provides a theoretical understanding of the organisational framework of KTOs, addressing a crucial gap in the literature. Previous literature has mostly considered the organisational features of a KTO as given, and examined its impact on KT performance. However, given that third mission activities have become integral to universities, hence understanding their framework within which they are carried out is crucial both from an academic and practitioner point of view. Our paper goes into the heart of the choices available to university managers on designing and implementing a local KT model, and connects these choices to the university context.

Since this is one of the first attempts at understanding this phenomenon, it is not without its limitations. Given that our findings are based on a small sample, caution needs to be exercised when interpreting the propositions. First, it is entirely possible that each of these contextual factors affect more than one aspect of the KTO, which our small sample has not been able to capture. Secondly, the case analyses were not able to uncover the impact of other factors such as age, location, nature of KTO managerial staff, features of the student population etc. which might have an impact on the KTO's activities. And finally, given the cross nature of the study, we were not able to explore potential feedback effects of the locally implemented KT model on university level characteristics.

The theoretical contribution in this paper paves way for further studies which can examine the links between contextual factors and organisational setup in further detail. We established that the KTOs and localised processes not only act as a key enabler in creating and maintaining opportunities for transfer of knowledge, but are themselves shaped and structured by the history and characteristics of the universities they are a part of. The frameworks and generic KT models presented here provide a useful point of reference and a template, which can be adapted according to their unique needs and characteristics.

Tables

Type/Theme	Meaning & Association	Type/Theme	Meaning & Association
Emergent themes	Themes revealing information about the local university context. The questions did not probe directly but were allowed to emerge organically from the data and coding.	Descriptive themes	Themes revealing information about the locally implemented model of KT. The questions probed directly for these themes.
Strategy	Overall direction, long term vision and goals	Structure	Centralisation or devolution of activities
Tactics	Steps implemented to achieve strategic aims or short term vision and goals	Model	Degree of outsourcing or use of external agency
External orientation	Awareness about external world; learning,	Preference	Stated or revealed preference on channels of KT or any other activity
Performance	Measure or qualitative judgement about levels of KT, research and other activities	Scale	Quantity or breadth of activity
		Change	Aspects of past or ongoing changes within organisation or externally
		Research	Quality, quantity, nature of research
		Operations	Processes, standards, regular activities

Table 1: Taxonomy of themes used in the analysis of primary data.

University	Unit	Commentary	Emerging themes	Descriptive themes
Oxford	RS	<i>Research services manages pre and post award support, contracts and impact</i>	strategy	operations
	RS	<i>ISIS looks after most of the IP related transactions and consulting</i>	strategy	model, operations
	RS	<i>We interact closely with other regional players to build an ecosystem</i>	external orientation	operations
	ISIS	<i>We have been very successful with licensing, with over 20% patents licensed out</i>	performance	preference
	ISIS	<i>The primary aim underlying all our licensing activity is maximizing the number of contracts, not revenue</i>	strategy	preference
	ISIS	<i>We provide access to Oxford's world class expertise</i>	external orientation	operations
	Faculty	<i>The arrangement with ISIS is working well...can't see reasons for major changes in the near future.</i>	tactics	change
Durham	DBIS	<i>Nowadays we put less priority on patents and licensing by themselves...spin outs are being maintained although the sector as a whole haven't done well in this regard.</i>	strategy	preference
	DBIS	<i>We are encouraging more collaborative research with industry following general trends in the sector</i>	strategy, external orientation	preference
	DBIS	<i>DBIS underwent a restructuring a few years back and as a result, commercialisation and enterprise activities were brought under the same roof</i>	strategy, tactical	structure, change
	DBIS	<i>Spinout success has generally been declining in the UK...we are still waiting for the big exits to take place</i>	external orientation	change
	DBIS	<i>Multidisciplinarity definitely helps in industrial collaborations</i>	tactical	research

	Faculty	<i>DBIS carried out detailed discussions regarding potential for commercialisation</i>	tactical	operations
	Faculty	<i>Its good to have all services centrally located, my experience from previous employment wasn't great where they had outsourced</i>	external orientation, tactical	model, operations
Cranfield	KTO	<i>Faculty encouraged to be entrepreneurial, so may take things in their own hands</i>	strategy	structure, operations
	KTO	<i>We had a larger internal team with wider remit previously but significantly overhauled in 2006, and subcontracting model put in place</i>	strategy, external orientation	model
	KTO	<i>IP management in Cranfield is outsourced to ISIS Innovation</i>	tactical	model
	KTO	<i>CU attempts to recover costs very early in negotiations. Recovers costs strategically.</i>	strategy, tactical	operations
	Faculty	<i>Actually there is a lot of help available, but what is missing is really clarity about it all. There is a clear lack of knowledge in academics on what help is available and where to look for it</i>	tactical, external orientation	operations
Essex	REO	<i>REO staff engage with local and regional partners and firms through various formal and informal routes such as business breakfasts, KTNs, Essex alumni etc.</i>	external orientation	operations
	REO	<i>Essex has done very well with setting up KTPs, even though the overall number of KTPs have gone down in the sector.</i>	performance	preference
	REO	<i>Research here is more tilted towards fundamental as opposed to applied</i>	strategic	research
	REO	<i>The REO has the comprehensive mandate of covering research grants, collaboration management and commercialisation of research</i>	strategy, tactical	structure
	Faculty	<i>Colleagues in REO seem to be well tuned with the kind of research carried out in the departments...I guess one of the advantages of operating on a limited scale</i>	tactical	structure

Table 2: Examples of thematic classification of primary data collected from the four universities.

Themes	Strategy	Tactics	External Orientation	Performance
Structure	<p>Separate RC and AE units</p> <p>Spin outs, entrepreneurship supported by depts. and faculties</p> <p>OUI manages patenting, licensing, consulting</p> <p>Research Services oversees contracts and collaborations</p>	<p>Research Services manages IP negotiations but actual filing of patents and licensing is managed by OUI</p> <p>Research Services has 70+ members, many located physically close to the researchers</p> <p>Multiple channels of industry engagement involving staff dedicated to KT from all across OU</p>		<p>Contracts and collaborations form the bulk of KT</p> <p>Has been very successful in licensing (on average 20% of patents licensed)</p> <p>A small number of patents considered high impact</p> <p>Large proportion of revenue from non-patented IP</p>
Location	<p>OUI is an independent company</p> <p>Research Services is internal to OU</p>		<p>Patenting, licensing, consultancy management outsourced</p>	

Preference	All routes of KT explored Motivation of RS is academic, not commercial Motivation of OUI behind RC is to maximise number of deals and social benefit			It has been recognized that research and KT are parallel activities and that not all researchers can or will do both
Scale	Research is broad based and of high quality Research Services and OUI cover all areas of research		OUI provides access to OU expertise to external parties	
Change	OUI has to adapt to changes in global centres of production Move to outsourcing model has helped to concentrate on core strength of OU	Key challenge facing OU is constraints on translational funding	OU helping to build a regional innovation ecosystem through interactions with partner organizations	
Research	Emphasis on excellent research all round “Wider Engagement with Society is one of Oxford’s core strategic objectives.” Excellent research will eventually lead to “high impact” technologies		OUI manages an open innovation forum involving researchers and businesses	
Operations	RS acts as a conduit between researchers and OUI	RS has its own dedicated team dealing with IP rights management OUI recruits staff with PhDs and/or industry experience		Hands-off approach where researchers can engage in KT only if they so wish

Table 3: Thematic analysis of University of Oxford

Themes	Strategy	Tactics	External Orientation	Performance
Structure	Separate RC and AE units, but centralised within one roof of DBIS	Contract research is mostly channelled through the departments and Centres directly		Contract research is the largest component of KT High impact award winning collaborative arrangements have been established

Location	DBIS located internally within the university	External consultants are used for searches and examining business cases External patent attorneys used for filing	Use both internal and external resources for marketing newly developed technologies - Innovation Commons as a example of an external resource	
Preference	DBIS has wide remit but is increasingly preferring collaborative umbrella agreements with one or more partners AE channels clearly preferred over RC	Support for spin out vs licensing is carried out on a case by case basis		Collaborative research has increased substantially recently A large number of licenses have gone into spin outs historically. Their impact is yet to be assessed
Scale	Research is broad based	Moderately high number of industrial contracts Remit of patenting is generally UK, EU		
Change	Moderately late entrant into KT Took a hard look at its ambitions and achievements around 2008 and decided to restructure DBIS and adopt collaborative models	Partnerships require time and effort to build and sustain. Sufficient time is provided for these relationships to mature Effort is made to ensure turnover of people on either side does not affect sustainability of project	“Licensing and spin outs in UK have largely remained unsuccessful “ “Other universities are also moving to a collaborative model”	Have decreased the number of exclusive patents being filed, move towards joint filing From being a small player in KT, DU is now at par with average of Russell Group universities
Research	Multidisciplinary and/or co-produced research encouraged in Centres	DBIS helps to organise multidisciplinary teams across DU		
Operations	Joint IP generation with industry is preferred	Continued conversations with potential and current partners is key for collaborative arrangements These conversations are held at multiple levels and contact points New partners may be brought in over life time of one project given overlapping interests		Relatively small number of researchers involved with bulk of KT Hands off approach followed by DBIS, academic freedom is kept intact

Table 4: Thematic analysis of University of Durham

Themes	Strategy	Tactics	External Orientation	Performance
Structure	<p>Highly devolved model with no central KTO, Schools and departments encouraged to engage in KT independently</p> <p>Schools, departments and researchers incentivised to be entrepreneurial</p> <p>A skeletal central team in place to oversee RC</p>	<p>The five Schools are run as independent businesses</p> <p>Schools have attached companies providing research and contractual support for AE</p> <p>Schools negotiate contracts independently</p> <p>Central skeletal team supports patenting, licensing, spin outs with help of OUI, Cranfield Ventures etc.</p>	<p>Each School has independent commercial companies attached, which operate as normal businesses selling expertise and services externally</p>	<p>The independent companies attached to Schools are important sources of revenue for them</p>
Location	<p>Majority of RC functions outsourced</p>	<p>Non-exclusive contract with OUI, which provides advice, information etc.</p> <p>Patent filing, licensing negotiations carried out internally</p>	<p>Outsourced model for a section KT</p> <p>Uses a variety of external companies for patent filing, contracting support</p> <p>Spin out support from Cranfield Ventures, Business Incubation Centres and OUI</p>	
Preference	<p>Strong preference for contract research followed by other routes of AE</p> <p>Only minimal support for RC, for those technologies with very strong business case</p> <p>Strategic approach to patenting and licensing</p>	<p>Faculty encouraged to explore contracts independently and engage directly in negotiations</p> <p>Financial considerations drive the decision on whether to patent certain technologies</p> <p>Only those technologies patented, where chances of immediate licensing is high</p>	<p>Historically oriented towards industrial partnerships with large blue-chip firms and defence establishment</p>	<p>Contract research historically accounts for the largest component of KT</p> <p>CU is one of the few universities which have recovered most of its costs invested into IP protection and licensing</p>
Scale	<p>Strong focus on science and engineering</p> <p>CU is a wholly postgraduate university</p>			
Change	<p>IP management, especially RC has undergone radical changes – from a heavy centralised presence to being outsourced</p>	<p>The subcontracting model was put in place in 2006 to streamline the RC channel and make it financially viable</p>	<p>The emphasis on external partnerships with industry has remained unchanged, but modes and processes of have undergone changes</p>	

		Initial contract with Imperial Ventures, which was subsequently changed to OUI		
Research	CU embodies twin objectives of academic rigour and financial viability as part of its long term strategy and treats these independently Strong applied focus Historically close to industry and defence related topics	Faculty encouraged to explore RC and AE options very early in the lifetime of a research project No apparent conflict between publication and KT motives Researchers may not always be aware of all alternatives, especially when they are new	Applied industry relevant research is encouraged	
Operations	Recovery of costs from investments in KT and financial considerations are given high priority	Researchers incentivised for being entrepreneurial and active in KT Independent consulting by researchers are not encouraged Relationship with OUI flexible and non-exclusive		IP related contracts are put in place early in any research project's lifetime Attempts are made very early to recover costs related to IP protection and licensing

Table 5: Thematic analysis of Cranfield University

Themes	Strategy	Tactics	External Orientation	Performance
Structure	REO is centralised and manages all aspects of KT	Income sharing arrangements are generously in favour of researchers		
Location	REO is located wholly within the university		REO uses external partners for technology evaluation, patent filing etc.	
Preference	Does not discriminate between various channels but finds RC challenging, given the nature of research in UE Increasingly the focus is on specialised channels of AE	Actively explores alternative models of AE, such as KTPs and Innovation Voucher systems KTPs are popular and have been frequently used in the last five years		UE has witnessed a growth KTPs recently, with a number of on-going and completed projects. A small number of spin outs have been supported by the REO in recent years

Scale	<p>REO has a comprehensive mandate of managing research grants, as well as all aspects of KT</p> <p>There is a strong focus on social science and humanities disciplines</p>	<p>REO provides support for all avenues of KT</p>		
Change	<p>Traditionally attempted to carry out RC, but given UE's poor record in RC, it is increasingly exploring AE channels more</p> <p>"There is a lot of potential for Essex to increase revenue from knowledge transfer"</p> <p>There is need for a change in the way research is carried out in UE</p>			<p>Contracts and Collaborations have been established as well, not in traditional science and technology domains, but in social science and humanities</p> <p>Overall figures are still modest, but there has been significant growth in revenue from KT activities in recent years.</p>
Research	<p>Research largely focuses around social sciences and humanities, with only a few strong science and technology departments</p> <p>The focus is more around blue sky research rather than applied</p>	<p>Research is carried out in small teams within departments</p> <p>Research teams lack critical mass</p>		<p>Researchers are becoming aware of KT opportunities, especially through recent successes in KTPs. There is growing interest in exploring KT avenues.</p> <p>The emphasis placed by Research Councils on research impact has also contributed towards growing interest in KT.</p>
Operations		<p>Although centralised, given overall size REO has dedicated managers for faculties and departments who are able to liaise with academic researchers directly if needed</p> <p>REO does not aggressively pursue KT opportunities allowing researchers to bring potential ideas to them</p>		<p>KTPs and Innovation Vouchers are easier to set up, and seen to be preferred by small to medium firms</p>

Table 6: Thematic analysis of University of Essex

Cases	Oxford	Durham	Cranfield	Essex
Characteristics				
Research Quality	Very high and highly reputed	High	Medium low	Medium low
Research Breadth	Very broad, covering all disciplines	Broad, but especially reputed for science and technology	Narrow, with focus on science and technology	Narrow, with focus on social sciences
Structure of KTO	Partly centralised. Explicit division between RC and AE responsibilities	Centralised. Implicit division between RC and AE responsibilities.	Devolved to Schools and Departments.	Centralised
Business Model of KTO	Partly outsourced (RC and Consulting)	Internal	Outsourced.	Internal
Strategic Preference for Channels (by value)	Stated: All RC and AE channels	Stated: AE, generally collaborations through umbrella agreements.	Stated: AE, generally contracts	Stated: All AE channels
RC Success	Very successful	Not successful	Moderately successful. Good return on investment.	Not successful
AE Success	Very successful, mostly contracts	Moderately successful, mostly contracts	Successful, mostly contracts.	Moderately successful, contracts and KTPs

Table 7: Comparison of the case studies with respect to KT organization and research outcomes in each.

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