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Citation: Cunningham, James, Menter, Matthias and Young, Chris (2016) A review of qualitative case methods trends and themes used in technology transfer research. The Journal of Technology Transfer. ISSN 0892-9912 (In Press)

Published by: Springer

URL: <http://dx.doi.org/10.1007/s10961-016-9491-6> <<http://dx.doi.org/10.1007/s10961-016-9491-6>>

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Pre Print Version

A Review of Qualitative Case Methods Trends and Themes used in Technology Transfer Research

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Full final published version of this paper is available at <http://rdcu.be/jXzT>

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Abstract

The focus of this paper is to review the qualitative case methods that have been used in technology transfer research over the last 20 years from 1996 to 2015. Qualitative case methods allow for more in-depth analyses and provide the opportunity to place research into a certain context due to the selection of e.g. specific sectors, institutions, countries, etc. Using a systematic literature review of five of the top journals in the field of technology transfer research, namely *Journal of Technology Transfer*, *Research Policy*, *Science and Public Policy*, *R&D Management* and *Technovation*, it yielded 107 articles using the search terms: “Technology Transfer” AND (“Case Study” OR “Case Method” OR “Qualitative”). Our findings found a clustering of themes using qualitative case methods around technology transfer mechanisms and TTOs, academic entrepreneurship, university-industry collaboration, commercialization as well as R&D and firm knowledge transfer. We also identify trends in case method technology transfer research with respect to authorship, location of papers, sectoral contexts, data collection, numbers of cases and data analysis software. We conclude our paper discussing the implications of trends and themes and suggest that researchers need to reflect on used terminology to describe qualitative case methods and their utilization. We conclude by postulating a to advance technology transfer researcher further there is a need for more plurality of data collection methods for qualitative case methods research.

Keywords: Technology Transfer · Case Method · Case Study · Qualitative · Research Methods · Data Collection; Cases; Commercialization; Academic Entrepreneurship; Technology Transfer

JEL Classification: C42 · O32 · O33

1. Introduction

Technology transfer is a rapidly growing field and this has resulted in a growing empirical base that has shaped policy and practice (see Bozeman, 2000; Debackere and Veugeler, 2005; Etzkowitz, 2016; Grimaldi et al. 2011; Link et al., 2011; Shane, 2004; Siegel et al. 2007). The field has focused on a variety of themes and actors in different institutional and country settings (see Bozeman, Fay, & Slade, 2013). At a macro level, a growing body of research has focused on issues such as the triple helix (Leydesdorff & Etzkowitz, 1996), entrepreneurial ecosystems (Wright, 2014), national systems of innovation (Acs et al. 2016) and new emerging themes, such as public sector entrepreneurship (Leyden & Link, 2015). More intense theoretical and empirical focus has been placed on understanding the various facets surrounding successful technology transfer between universities and industry (see Perkmann et al., 2013). This research has unearthed some of the antecedent characteristics and the benefits of technology transfer and has reinforced the interest on the different technology transfer mechanisms (Siegel, Waldman, Atwater, & Link, 2004) and corresponding technology transfer effectiveness (Bozeman, Rimes, & Youtie, 2015). A growing body of literature is developing on the role of individual actors such as scientists, venture capitalists, consultants etc. in the technology transfer process and how these actors can shape and influence the technology transfer process (Audretsch et al. 2016; Cunningham et al. 2016). Some recent micro level research on technology transfer has focused on barriers and stimulants and motivations of different actors as well as on the influence of individual actors on the technology transfer processes (Cunningham et al. 2014 & 2015; Menter, 2016).

In the development of the research field related to technology transfer, a variety of methodological approaches has been used; however, there has been no systematic examination or reflective analysis on the research methods used that have advanced research in this field. To date, there has been no reflective focus on the methodological approaches – quantitative or qualitative – that researchers have used to study technology transfer. Such methodological reflects are common in other fields such as international entrepreneurship (see Coviello and Jones, 2004) and management (see Scandura and Williams, 2000). Given the growth of the technology transfer research over the last three decades, there is now a need to understand the underpinning methodological approaches that have been used to advance the technology transfer field, particularly with respect to qualitative case methods. Especially in growing fields of research such as technology transfer, considerations about the adequate usage of methodological approaches and terminology as well as the general scope of research are crucial to progress within the field and that this is underpinned with robust methodological approaches. Moreover, an overview of recent trends and themes thereby enables researchers to work on relevant research fields offering further insights into previously neglected areas of research, yet referring to previous work within the field. Such a review also provides researchers with an opportunity to reflect on and shape their own methodological approaches within the field and in doing so consider such questions as data collection approaches and sample sizes.

Using a systematic literature review of five of the top journals in the field of technology transfer, namely *Journal of Technology Transfer*, *Research Policy*, *Science and Public Policy*, *R&D Management* and *Technovation*, we identified studies utilizing qualitative case methods over the last 20 years from 1996 through 2015. The purpose of our paper is to examine qualitative case methods trends and themes used in technology

transfer research. It also provides an opportunity to further critically reflect on the application of qualitative case methods in this field. Furthermore, we aim at stimulating the reflection of case methods terminology, their utilization as well as of data collection methods. Finally, we want to emphasize the general increase of qualitative case methods in technology transfer research and guide and encourage further research in this direction.

Our paper is organised as follows. In section 2, our literature review focuses on case methods in terms of definitions, benefits and previous studies in other fields of research. In section 3, we outline the methods that we used in our study and in section 4, we present our findings. We conclude the paper with a discussion of our findings and outline the main implications for the field of technology transfer research with respect to the consistent usage of terminology, the plurality of data collection methods as well as qualitative and quantitative research designs.

2. Literature Review

2.1 Qualitative Case Methods Research Studies in other Research Fields

While the use of qualitative case methods in technology transfer research is increasing, there has been no study of qualitative case methods on technology transfer research yet. In other fields of research, reviews on themes and trends of qualitative case methods are more common. For example, in the field of information system (IS) single and multiple qualitative case study approaches, according to Shakir (2002), is well suited to the field and is continuously growing in popularity amongst researchers. Similarly, Walsham (1995) notes the increase in studies in the IS field and highlights the challenges and implications for researchers pursuing this methodological approach. In the field of organisation studies, Locke and Golden-Biddle (1997) outline the use of qualitative case methods within the two highly regarded journals, namely *Academy of Management Journal* and *Administrative Science Quarterly*. They found that the published work of organizational studies scholars consists not only of the presentation of data and does not only array ‘facts’ and evidence logically but weaves persuasive practices into texts, even as the authors structure the coherence of the intertextual fields. Other fields also have noted the increased utilization of qualitative case methods such as management accounting (Scapens, 1990), strategic management (Hoskisson, Hitt, Wan, & Yiu, 1999), marketing (Easton, 2010), international political economy (Odell, 2001), SME firms (Chetty, 1996; Perren & Ram, 2004), logistics (Ellram, 1996) and operations management (Meredith, 1998). More recently in the field of entrepreneurship and small business, a study by Henry and Foss (2015) found a limited number of studies that use qualitative case methods and this had been applied across a variety of contexts such as family business, entrepreneurial networking and innovation. Henry and Foss (2015), based on their study, note that few papers published in entrepreneurship journals use qualitative case methods, suggesting that this research method is not fully accepted as a legitimate and rigorous approach within entrepreneurship scholarship and thus argue for a greater acceptance of the use of case methods.

2.2 Qualitative Case Methods and Technology Transfer Research

The term ‘case study’ is strongly related to qualitative research designs, although it is utilized in many different ways (Ritchie, Lewis, Nicholls, & Ormston, 2013). Case studies investigate a contemporary phenomenon where

the boundaries between the object of study and context are unclear (Yin, 2013).² Case study research is considered to be a preferred method of social science research in situations where the primary research questions are “how” and “why” questions, where the researcher is involved in doing an evaluation and where the researcher has minimal control over behavioural events (Bhattacharjee, 2012). A qualitative case study approach involves the investigation of a contemporary phenomenon in its real-world context where the object of study or its environment is not manipulated. Easton (2010, p. 119) defines case research ‘as a research method that involves investigating one or a small number of social entities or situations about which data are collected using multiple sources of data and developing a holistic description through an iterative research process’. This approach allows researchers to draw conclusions on the basis of a qualitative analysis from a single case study or from a comparative case study (Dul & Hak, 2008). Woodside and Wilson (2003, p. 493) note that the principal objective of qualitative case study research is about ‘achieving deep understanding of processes and other concept variables (e.g. actors’ perceptions of their own thinking processes, intentions and contextual influences)’. In conducting qualitative case research, Stuart et al. (2002) break down case research into five stages: defining the research question, instruments development and site selection, data gathering, analysing data and disseminating the research findings.

Among scholars in technology transfer research, there is an increasing consensus that technology transfer processes and the corresponding technology transfer effectiveness are subject to contextual influences, i.e. the primary research question is “when” (Autio et al., 2014). Studies that had used qualitative case methods have highlighted the importance of context when studying different aspects of technology transfer. Some examples of this contextual importance focusing on the complexities involved include the qualitative case study of Jain and George (2007) of Wisconsin Alumni Foundation which highlights the need for TTOs to have dual purposes as well as the study of Kingsley, Bozeman and Coker (1996) on evaluating technology transfer from research, development and demonstration (RD&D) using 31 cases studies. As a result, research methods which take the importance of context into account and enable researchers to control for respective influencing factors gain in significance, yet there still remains a dominance of quantitative studies in technology transfer research.

Challenges and Benefits of Qualitative Case Methods Research

Qualitative case methods research is not without its critics who originally viewed this method with scepticism arguing that they had unsystematic procedures and poor design and that they were less important than studies that produced generalisations for a whole population. Particular criticisms centred on internal and external validity (Stoecker, 1991), on unclear conventions concerning case analysis (Miles, 1979) as well as on rigor (Dubé & Paré, 2003; Hoskisson, Hitt, Wan, & Yiu, 1999). Specifically, Flyvberg (2006) identified and addressed what he examined as five misunderstandings of case study research including the theoretical knowledge, generalisability, generation of hypotheses, bias and appropriate summaries of case studies. Moreover, Johnson, Leach and Liu (1999) argue from a marketing domain perspective that case studies can contribute to theory building if researchers are systematic and rigorous in their approach. Furthermore, Welch et al. (2011) also argue that case studies can contribute to theory building. In the context of the international

² We use terms in this section of the paper such case methods, case based research and case studies these all refer to qualitative case methods.

business field, they suggest that there are four methods of theorising in the field: inductive theory building, interpretive sensemaking, natural experiment and contextualised explanation. Applying case methods research in a rigorous manner can contribute to theory building and it needs to pass the ‘tests of good theory’ as Eisenhardt (1989) argues. Handfield and Melynk (1998) suggest and outline potential matching research strategies to theory building when using case based methods. For example, they suggest using unfocused in-depth case studies and longitudinal case studies when the purpose of the research is focused on discovery, yet where the research purpose is mapping then focused case studies, in-depth field studies multiple cases studies constitute more appropriate data collection approaches.

Case based research according to Darke, Shanks and Broadbent (1998, p. 275) can be used ‘to provide descriptions phenomena, development theory and test theory’. However, Benbasat, Goldstein and Mead (1987, p. 369) argue that ‘case research is particularly appropriate for certain types of problems: those in which research and theory are at the early, formative, and, “sticky, practice based problems where the experiences of the actors are important and the context of action is critical”’. One of the real benefits of case methods affords researchers flexibility in approach while studying complex situations and contexts. Case methods research constitutes a useful research strategy for solving practical business problems and examining business theories but again represents a small percentage of total papers (Dul & Hak, 2008). More recently, case methods have become scientifically rigorous and are considered by some researchers as a complementary method to the quantitative approach (Gagnon, 2010). The validity of case study research can thereby be increased through triangulation with multiple means of data collection (Dul & Hak, 2008).

3. Methodology

3.1 Systematic Literature Review

To examine the trends and themes of qualitative case methods research used in technology transfer research, we undertook a comprehensive systematic literature review of articles published in the following five academic journals: *Journal of Technology Transfer*, *Research Policy*, *Science and Public Policy*, *R&D Management* and *Technovation*. A systematic review was selected as opposed to the traditional narrative literature reviews. Traditional literature reviews have been broadly criticised for their inadequate relevance due to the utilisation of personal, subjective and biased methodology by authors (see Becheikh, Landry, & Amara, 2006; Fink, 1998; Hart, 1998). Systematic literature reviews apply the same standards to secondary research as should be applied to primary research (Denyer & Neeley, 2004). Attributes of the systematic review include the development of clear and precise objectives, pre-planned methods, a comprehensive search of all potentially relevant articles, the use of explicit criteria for article selection, an evaluation of the quality of the research and findings, an integration of the individual studies as well as an impartial and coherent delivery of the results (Transfield, Denyer, & Smart, 2003).

Systematic literature reviews follow an explicit, rigorous, and transparent methodology and therefore constitute a well-established approach in analysing trends and developments in a certain research field. In contrast to the traditional literature review, the systematic review aims to minimise error and bias in order to increase the quality of the review by using explicit and rigorous methods to identify, appraise and incorporate research on

specific research questions (Ivarsson & Gorschek, 2009). A further strength of the systematic literature review is its transparency and openness to critique (Pittaway & Cope, 2007). The chosen systematic literature review is particularly useful for analysing large quantities of longitudinal data (Denyer & Neeley, 2004).

The primary purpose of our systematic review is to identify key contributions to a specific field or research question, namely technology transfer research, and to descriptively present and discuss these findings. Given the growing body of research on technology transfer it is important to gain a common understanding of methodological approaches, respective terminology and research designs to consistently progress within in the field. Systematic literature reviews thereby involve two processes: the first process concerns defining review protocols and field mapping while the second process involves reporting the findings (see Transfield et al., 2003; Pittaway et al., 2004; Macpherson & Holt, 2007).

3.2 Defining Protocols

The protocol contains information on the precise questions that the study addresses, the study's population, the search strategy as well as the criteria for the inclusion and exclusion of studies (Transfield et al., 2003). This review's population was restricted to published academic articles in the following leading journals focusing on technology transfer research including the years from 1996 to 2015: *Journal of Technology Transfer*, *Research Policy*, *Science and Public Policy*, *R&D Management* as well as *Technovation*. A systematic Boolean keyword search was conducted within each journal including the terms: "Technology Transfer" AND ("Case Study" OR "Case Method" OR "Qualitative"). The studies that met the inclusion criteria specified in the protocol yielded 116 papers that used case methods utilizing the specific search strings. In order to validate the search results, we analysed the abstract of each of the 116 articles and checked for accuracy concerning our defined protocols, i.e. applied case methods in the context of technology transfer research. Upon removal of duplicate studies and papers that did not use case methods, such as special issue editorials, a total of 107 articles were included in the review (see Appendix 1).

3.3 Mapping the Field

Our final 107 articles were managed via a spreadsheet database using 23 fields (see Appendix 2 for an excerpt of our spreadsheet database). The fields included the article's name, author(s) and their affiliations, year of publication, journal, duration of the study, theme, research question(s), keywords, location, unit of analysis, sector, number of cases, method(s), data collection, data analysis, data analysis software, findings and implications. These fields were chosen in order to allow for homogenous data extraction in preparation for the efficient analysis of the data.

3.4 Analysis

The process of data analysis is defined by Zikmund et al. (2013) as being the application of reasoning to understand and interpret the data that has been collected. The analysis of the data within the spreadsheet allowed for the identification and critique of the dominant themes that emerged from the systematic literature review as well as the key results and findings. Linking the themes across the various core contributions and subsequently

highlighting such links is a necessary part of the analysis stage (Transfield et al., 2003). Reoccurring themes, units of analysis, sectors, data collection and data analysis methods were identified and recorded.

Our spreadsheet database served as a basis for the identification of commonalities among the 107 articles. By implementing a coding scheme and by in-depth analyses of technology transfer research trends, we were able to aggregate the papers and synthesize five distinct themes. We did this by each author coding individually and then we shared and agreed final coding to aggregate and synthesize five distinct themes. It is important to note that one article could thereby be assigned to more than one theme if appropriate. The following section outlines our key findings with respect to case methods trends and themes used in technology transfer research.

4. Findings

4.1 Range and Number of Articles

The total number of studies found within all five journals that met all the inclusion criteria specified in the protocol ranged from only one in 1996 up to twelve in 2014. This identifies a small increase in qualitative case methods studies over the period between 1996 and 2014. The individual journal that yielded the highest number of studies was the *Journal of Technology Transfer*, yielding 8 articles in 2014. In 1996, the journal *Research Policy* alone published one qualitative case methods study and not until 1999 were another 2 articles published; again, only in *Research Policy*. The fluctuating, minimal increase illustrated by the line graph (see Figure 1) identifies that although there has been a slight increase in qualitative case methods studies, it is still an under-utilized approach. The total number of articles published in 2015 gives rise to only 2 articles. As the systematic literature review was undertaken in the first quarter of 2015, some articles of 2015 had not yet been published giving rise to the low number of articles in this year. In general, the number of published articles that have used case methods is comparable low, suggesting that other methodological approaches are more dominant.

– Insert Figure 1 about here –

4.2 Main Research Themes

From our individual coding and through the authors' collective consensus, we identified five thematic categories within the five journals between 1996 and 2015 (see Figure 2). We have detailed keywords for each of our five themes (see Figure 2) and based on this, there is a huge variety of keywords. We also conducted a similar exercise for our sectoral analysis. The most common reoccurring theme is 'Technology Transfer Mechanisms and Technology Transfer Offices' giving rise to a total of 70 articles. The *Journal of Technology Transfer* has published the largest number of articles related to this theme category with a frequency of 37 articles, followed by the journal *Technovation* with a frequency of 16. The next most common reoccurring theme is 'R&D and firm knowledge transfer' giving rise to a total of 56 articles with *Journal of Technology Transfer* publishing more than half of this total. The least common reoccurring theme is the thematic category of 'University-Industry Collaboration' with a total theme occurrence of 15. *R&D Management* proved to be the journal with the least number of reoccurring themes accumulating a total of 14 occurrences of the thematic categories. *Research Policy* in turn provided for a total of 29 of the thematic categories. The thematic category of 'Academic Entrepreneurship' produces a frequency of 46 occurrences with the *Journal of Technology Transfer*

accounting for 63% of total occurrences. The thematic category of ‘Commercialization’ accounted for 17% of the total thematic categories, again with *Journal of Technology Transfer* accounting for the most occurrences, followed by *Technovation*. The dominant focus on technology transfer mechanisms and TTOs reflects a predominant focus within the field using other methodological approaches.

– Insert Figure 2 about here –

4.3 Authorship

Using qualitative case methods research data collection can take longer and involve multiple sources. Table 1 illustrates the number of authors who have published more than one article related to case methods in technology transfer research. No author between 1996 and 2014 has published more than 3 papers, highlighting the lack of research and revisited research within the field of technology transfer research. Similar results have been derived by Ghio et al. (2015) in their in-depth co-authorship analysis focusing on the evolution of the ‘Knowledge Spillover Theory of Entrepreneurship’. Their study revealed the concentration of this strand of literature on a limited set of central authors.

– Insert Table 1 about here –

Most of the 107 case methods studies have been published by a single author accounting for 34 studies, followed by 31 dual authorships and 29 articles written by three authors. There are 11 studies that were written by 4 authors and only 2 papers written by 5 authors (see Figure 3).

– Insert Figure 3 about here –

4.4 Location of Paper and Affiliation of Author

Qualitative case studies are always associated with certain contexts. Interestingly, some contexts triggered more in-depth analyses than others, leading to the question which contexts are mostly studied and why. In examining the location of the paper and affiliation of the authors, we were interested in examining the country location of the case methods paper and whether authors were utilising data from their own country of affiliation or other countries. Figure 4 outlines which countries each of the case methods papers are based on as well as the country of affiliation of the author. Out of the total 107 papers, 28 of these are based on the USA, followed by 16 studies on the UK and 7 studies on Germany, Italy and China. Some 60 authors are affiliated with the USA, followed by 29 authors from the UK, 18 from Spain, 18 from Canada and 12 from Italy. Some 45 authors affiliated with the USA wrote papers about the USA indicating a 75% rate of authors affiliated with the USA who wrote papers about their own country³. Some 20 authors affiliated with the UK have completed studies on the UK giving rise to a 68% rate. The 12 Spanish authors completed studies based on Spain giving a 67% rate and similarly 12 Canadian authors completed studies on Canada indicating a 67% rate and indicating a consistently high level of sample convenience. These results indicate that the location of the authors matters: authors utilize their personal networks and relationships to conduct case methods research.

³ Due to multiple authorships, the number of authors exceeds the number of papers

A minority of authors completed studies not based on their affiliated country. Some 9 authors from the USA wrote papers that were not based on the USA indicating a rate of only 15%, while 7 authors from the UK completed studies that were not based on the UK indicating a rate of 24%. Some 80% of French authors however, have completed studies based on countries other than France while all 3 of the Danish authors completed their studies on foreign countries. Some 5 USA affiliated authors have completed studies that are based on both the USA and other countries while 4 Swiss and 4 Irish authors have completed studies on both their home country and foreign countries. These findings would suggest that researchers' dominant preferences are to focus their studies in the country where they are affiliated to and there are small numbers of authors who base their studies other countries. Furthermore, our findings show that there is a US dominance for location of papers and affiliation of authors and there is an under-representation of emerging and Asian economies as well as from countries where economies are well advanced in terms of R&D investment and innovation such as Finland and the Netherlands.

– Insert Figure 4 about here –

4.5 Sectoral Contexts

Seven sectoral categories were identified from the analysis of the 107 qualitative case methods studies based on individual author coding and through the authors' collective consensus. The 'manufacturing industry' yielded a total of 66 occurrences, within *Journal of Technology Transfer* accounting for almost half of these, followed by *Technovation* accounting for 22 articles. Although the *Journal of Technology Transfer* yielded the largest overall occurrences of the 'manufacturing sector' almost half (46%) of all studies within the journal *R&D Management* had a focus on this sector. The next most analysed sector was 'health and biotechnology' accounting for a total of 53 occurrences, again with *Journal of Technology Transfer* accounting for 62% of all instances of this sector. The 'software and ICT' sector yielded a total of 49 occurrences with *Journal of Technology Transfer* accounting for half of the total occurrences. The sector with the least amount of focus was the 'chemical industry' yielding a total of only 7 occurrences. The journals *Research Policy*, *Science and Public Policy* as well as *Technovation* yielded no instances of the 'chemical industry'. Overall our findings highlight the significant range of sectoral contexts that have been used by authors using case methods research in the field of technology transfer. This range of sectoral contexts has yet changed its focus over time. Whereas the manufacturing industry had previously been the main focus of case methods studies, this focus has now changed towards high-tech and emerging industries such as the health and biotechnology, the software and ICT as well as the energy and renewable resources industry. One explanation for this general development towards knowledge-intensive industries is provided by Audretsch, Lehmann, and Wright (2014) as they argue that the emergence of new technologies functions as the driving force and enabling factor to globalization.

– Insert Figure 5 about here –

4.6 Data Collection

We categorised the primary and secondary data collection methods based on the descriptions used by the authors in their published papers (see Figure 6). We found that the most frequently used primary data collection methods were semi-structured face-to-face interviews, telephone interviews and questionnaires which we subsumed under the category ‘interviews’. Furthermore, we identified nine descriptors used by authors in outlining primary data collection using interviews. Such methods of primary data collection would be considered a traditional one among qualitative researchers. Other means of collecting primary data collection such as focus groups and action research have been used less frequently, indicating that authors are favouring more traditional and safe approaches to data collection. Interestingly, authors used a wide variety of descriptions in relation to primary data collection, particularly those associated with interviews. Consequently there is a need for future researchers to be clearer and more precise use of terminology to describe primary data collection.

The top three descriptors we found in analysing the papers in our study for secondary data collection methods have been data reports, websites and newspapers. What is interesting to note is the wide variety of secondary data collection sources that we found in analysing the papers in our study and the frequency of data from previous studies, visual records and archival records. These findings suggest that authors using qualitative case methods are using more multiple sources of secondary data. From the descriptions of primary and secondary data collection in our study that authors use a variety of terms such as for data. Our findings suggest that authors in using qualitative case methods are opting for more traditional methods of data collection and we suggest that one of the drivers of this is around ensuring that their studies have a higher probability of being published and convincing reviewers of the rigor that they have applied to their case methods.

– *Insert Figure 6 about here* –

One of the questions facing case methods researchers is how many data sources are required to conduct a study. We found from the papers in our study that frequency of multiple data collection was higher to single by nearly a 3 to 1 ratio (see Figure 7). Due to the multitude of perspectives derived from multiple data collection methods, the robustness of research results increases by having more than just one data source. Consequently, multiple data collection methods increasingly gain in importance (Creswell, 2013). The qualitative case methods articles published in *Research Policy* utilise an equal number of single data collection methods to multiple data collection methods. This clarifies the wider use of mixed-modes of data collection in qualitative case methods studies. Our findings would suggest that data authors in designing case methods papers should select their data collection approaches carefully and consider a data collection approach that fits their research question and helps them to support their argumentation most effectively.

– *Insert Figure 7 about here* –

4.7 Number of Cases

A key issue for qualitative case methods researchers is how many cases are needed for their studies. In analysing the papers, we found that 42 papers used between one and four cases and 33 papers used more than 25 cases (see Figure 8). This suggests that there are two case extremes emerging, those studies that rely on a small

number of cases and authors that used a significant number of cases for their studies. We suggest that this heterogeneity in the number of cases is beneficial for the field of technology transfer research as it gives case methods researchers continued flexibility as to the number of cases as our findings clearly show that journals in our study publish papers using both low and higher number of cases.

– Insert Figure 8 about here –

4.8 Data Analysis and Data Analysis Software

There is a growing array of data analysis software available to support qualitative case methods researchers in analysing data. We found that studies utilizing data analysis software constitute a minority. Only 14 papers used data analysis software and the most used analytical software tool was N-Vivo analysis (see Figure 9). The N-Vivo analysis software was used three times in 2014 and once in 2010 by articles published in the *Journal of Technology Transfer and Technovation*.

– Insert Figure 9 about here –

In analysing the methods of data analyses we found that authors used a wide variety of descriptions in relation to the data analysis they used (see Figure 10). These descriptions were grouped under five data analysis categories. Some 42% of the 107 studies used a form of case study analysis while 22% used a method of qualitative analysis, some 14% used data triangulation, 14% for miscellaneous and less than 10% used literature analysis.

– Insert Figure 10 about here –

5. Discussion

What is overall evident from our study is that qualitative case methods are still in an emergent state within the field of technology transfer research. Thus, continuing to progress qualitative case methods based studies have an important contribution to make to advancing knowledge and for theory building. It also places onus on case methods researchers to be conscious in the description and precision in how they outline case methods used, to provide more detailed accounts of the data collection and analysis they used as well as being more experimental in using a wider range of data collection methods and analytical approaches in further studies. Moreover, our findings highlight that top journals do publish qualitative case methods research from a variety of sectoral contexts using single and multiple data collection sources.

In reflecting on the trends with respect to affiliated locations of authors, our findings especially concerning North America, UK and Canada, which is not surprising given the emergence and growth of the field of technology transfer research from North America in particular over the last three decades. Political interventions such as the Bayh-Dole Act in North America (Mowery, Nelson, Sampat, & Ziedonis, 2015) triggered qualitative case methods research focusing on the effects of technology transfer. What is surprising is that there is a growing spread of affiliated locations throughout different continents. However, there is a deficit with respect to emerging continents such as Africa, emerging Eastern European countries and high growth economies such as

India. For countries with advanced national innovation systems (Castellacci & Natera, 2013) such as Japan and South Korea it is surprising that we did not find more qualitative case methods studies. More studies from these regions are needed that can both offer further contributions to developing the field but also insights into different contextual approaches and practices.

The predominant research theme on technology transfer mechanisms and TTOs that we found is not surprising as it forms the basis for all other strands of literature within technology transfer research (Villani, Rasmussen, & Grimaldi, 2016). In aggregating this category for the purposes of our study it proved challenging to condense different articles due to the growth of new terms such to describe technology transfer as ‘knowledge transfer’, ‘technology transferences’, etc. The same issues occurred within the research field of academic entrepreneurship and how it is interpreted as a term within the field. Behind our findings, it gives rise to an interesting issue, namely that of interpretations of commonly used terms within the field. On the one hand loose and growing terms to describe a phenomenon under study can be helpful in growing and developing a field. On the other hand, it can also create confusion and potentially undermine the empirical results and intentionality of contributions from researchers. Particularly with respect to qualitative case methods research, researchers have to be particularly conscious and consistent with their use and interpretation of key themes that they build their studies around. At the current stage of the development of the field of technology transfer research, there is a need to reflect on commonly used terminology and its utilization within the field as well as how it should be understood for future studies. The consistent and precise utilization of terminology thereby has to comprise both content and methodology to overcome critics designating case methods as less rigorous (Dubé & Paré, 2003; Hoskisson, Hitt, Wan, & Yiu, 1999). Moreover, qualitative case study researchers need to be aware of the criticisms of using this approach particularly in relation to validity (Stoecker, 1991), formulation of case analysis (Miles, 1979), as well as bias, generalisability and hypotheses generation (Flyvberg, 2006). In designing studies using qualitative case methods, researchers need to consider carefully these criticisms, also with regard to their intended contribution, i.e. choosing the appropriate data collection approach. Rigor has to pervade all aspects of qualitative case methods researcher activities. This for example requires more explicit descriptions of data analysis conducted such as first and second order coding that was undertaken by the (single or multiple) case analysis (see O’Kane et al, 2015). Given the movement of the field toward a micro level analysis embracing and utilising more data collection approaches and data analysis, techniques can make a substantive contribution to generating new knowledge as well as providing insights that are relevant to technology transfer practitioners (Cunningham et al, 2016). It is clear that there is much scope for more case methods research developing within the field of technology transfer and within the broad themes that we have identified.

Our findings show that there is a focus on a limited number of data collection approaches with interviews, data, reports and documents being the predominate sources of data. Within the interview category, we found a wide variety of descriptions used. For data, reports and documents researchers used a wide variety of sources. It is encouraging to find such an array of sources. However, we suggest that there is room for the use of more data collections sources that would further enhance qualitative case methods studies. Approaches such as ethnographic methods, participant observations and focus groups can contribute to the development of the field.

We suggest that there is a need for even more plurality of data collection methods as this will deepen and strengthen further the field of technology transfer research as well as complement more quantitative studies. Also in furthering rigor, there are significant opportunities for qualitative case methods researchers to adopt data triangulation, which is used by only a small percentage of researchers in our study.

For qualitative case methods researchers, our study shows that there is a nearly 3 to 1 ratio of multiple data collection to single data collection. This would suggest that multiple data collection is favoured more by researchers and also by the journals in our study but also is reassuring that single data collection approaches are being published by high impact journals in the field. This has implications for qualitative case methods researchers in terms of theory development and generalisability of their studies. Our study has found that there is a range of data collection methods and the implications for researchers using qualitative case methods is that they have to be clear what contribution they are seeking to make which in turn determines the range for their study. Where we see further opportunities is in relation to growing multiple data collection across countries.

The question how many cases are sufficient for a qualitative case methods study is one that is of concern for qualitative case methods researchers. Our findings show that the majority of researchers used less than four cases or more than twenty-five cases. Within the field we are seeing two extremes and our breakdown of the journals in our study would indicate that journals are open to publishing papers with a range of number of cases. Small numbers of cases allow for in-depth analyses. Larger numbers of cases might support the generalisability of the findings. What surprised to us is the limited use of data analysis software. As the field evolves further, there is a need for case methods researchers to be more descriptive in relation to the analysis they conducted irrespective of whether they used data analysis software or not. It would further increase the efficiency of data preparation and exploitation in case of large amounts of data.

Finally, our analysis revealed a very broad sectoral activity focus with an emphasis on certain sectors such as 'health and biotechnology' as well as 'manufacturing'. We suggest that there is a need to both focus on sectors that are constantly increasing in importance such as the energy industry shifting towards renewable energies or knowledge intense service enterprises as well as on cross-sectoral studies combining different perspectives from different industries. Thus, scholars should establish a more holistic picture concerning technology transfer processes and corresponding effectiveness in distinct sectors. Also there are opportunities to apply qualitative case methods to examining technology transfer processes in the digital and circular economies. Overall, opportunities also lie in advancing knowledge in the field using longitudinal sector data that utilizes qualitative case methods and quantitative approaches.

6. Conclusion

We believe that our extensive systematic literature review on qualitative case methods in technology transfer research has produced three important implications for the field. First, future qualitative case methods researchers should reflect on used terminology and its utilization both concerning content and methodology. Only a consistent and adequate utilization of terminology enables the advancement of technology transfer and qualitative case methods research to address robustly and overcome on-going criticisms of case methods. To

address this, case methods researchers should be clear in their use of terminology, research objectives, data collection and data analysis. A systematic approach to rigor by researchers allays critics, retains the flexibility of approach that is required and also contributes in an effective way to the on-going development of the field.

Second, there is a clear need for more plurality of data collection methods in combination with a more intense usage of data analysis software. On the one hand, this enables researchers to advance the field of technology transfer research as well as to complement more quantitative studies. On the other hand, data analysis software allows for processing larger amount of data, resulting in the possibility of more in-depth analyses. We would encourage qualitative case methods researchers to be more ambitious and innovative in their data collection approaches. This boldness and ambition is necessary to develop the field around the five themes we have identified, but also in opening up new research themes.

Third, case methods in technology transfer research should make use of cross-sectoral as well as cross-country research designs to again allow for more in-depth analyses as well as to make use of different perspectives to create a more holistic picture concerning the field of technology transfer research. The combination of both qualitative and quantitative research designs opens up new research trajectories to create further insights into the processes and mechanisms of technology transfer as well as its corresponding effectiveness.

In conclusion, Flyvberg (2006, p. 219) argues that a ‘scientific discipline without a large number of thoroughly executed cases studies is a discipline without systematic production of exemplars, and a discipline without exemplars is an ineffective one’. Our paper highlights essential necessities and opportunities for qualitative case methods researchers to further contribute to the advancement of knowledge in the field of technology transfer research and qualitative case methods in general.

Acknowledgements

James A Cunningham acknowledges the funding support of Science Foundation Ireland (SFI) and co-funded under the European Regional Development Fund under Grant Number 13/RC/2073.

Conflict of Interest

The authors have no conflict of interest.

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Appendix 1 – Overview of Themes and Articles

Theme: Technology Transfer Mechanisms & TTOs

| Author(s) | Journal |
|------------------------------------|---------------------------------------|
| Acworth (2008) | <i>Research Policy</i> |
| Albors et al. (2006) | <i>Journal of Technology Transfer</i> |
| Bach et al. (2002) | <i>Journal of Technology Transfer</i> |
| Backman et al. (2007) | <i>R&D Management</i> |
| Bathelt et al. (2010) | <i>Technovation</i> |
| Becker & Gassmann (2006) | <i>Journal of Technology Transfer</i> |
| Bessant (1999) | <i>Research Policy</i> |
| Bianchi et al. (2011) | <i>R&D Management</i> |
| Boehm & Hogan (2014) | <i>Journal of Technology Transfer</i> |
| Cacciatori (2008) | <i>Research Policy</i> |
| Chapple et al. (2005) | <i>Research Policy</i> |
| Daellenbach & Davenport (2004) | <i>Journal of Technology Transfer</i> |
| Derrick (2014) | <i>Journal of Technology Transfer</i> |
| Díaz (2012) | <i>Journal of Technology Transfer</i> |
| Doganova (2013) | <i>Science and Public Policy</i> |
| Efstathiades et al. (2000) | <i>Technovation</i> |
| Fako et al. (2000) | <i>Journal of Technology Transfer</i> |
| Festel (2013) | <i>Journal of Technology Transfer</i> |
| Giaretta (2013) | <i>Journal of Technology Transfer</i> |
| Golob (2006) | <i>Journal of Technology Transfer</i> |
| Greiner & Franza (2003) | <i>Journal of Technology Transfer</i> |
| Guerrero & Urbano (2012) | <i>Journal of Technology Transfer</i> |
| Hansen & Ockwell (2014) | <i>Technovation</i> |
| Hess & Siegwart (2013) | <i>Journal of Technology Transfer</i> |
| Howells (2006) | <i>Research Policy</i> |
| Hussler et al. (2010) | <i>Technovation</i> |
| Intarakumnerd & Charoenporn (2015) | <i>Research Policy</i> |
| Jackson & Audretsch (2004) | <i>Journal of Technology Transfer</i> |
| Jolly (2004) | <i>R&D Management</i> |
| Juanola-Feliu et al. (2012) | <i>Technovation</i> |
| Kingsley et al. (1996) | <i>Research Policy</i> |
| Knie & Lengwiler (2008) | <i>Science and Public Policy</i> |
| Kroll & Liefner (2008) | <i>Technovation</i> |
| Kumar et al. (2007) | <i>Journal of Technology Transfer</i> |
| Landry et al. (2013) | <i>Technovation</i> |
| Leahy (2003) | <i>Journal of Technology Transfer</i> |
| Leitch & Harrison (2005) | <i>R&D Management</i> |
| Link & Siegel (2005) | <i>Research Policy</i> |
| Maia & Claro (2013) | <i>Journal of Technology Transfer</i> |
| Malik (2002) | <i>Technovation</i> |
| Marcotte & Niosi (2000) | <i>Journal of Technology Transfer</i> |
| Markman et al. (2004) | <i>Journal of Technology Transfer</i> |

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| Martinelli et al. (2008) | <i>Journal of Technology Transfer</i> |
| Matsumoto et al. (2010) | <i>R&D Management</i> |
| Moncada-Paternò-Castello et al. (2003) | <i>Technovation</i> |
| Moore & Thingane (2000) | <i>Journal of Technology Transfer</i> |
| Morandi (2013) | <i>Journal of Technology Transfer</i> |
| Moultrie (2015) | <i>Technovation</i> |
| Nilsson et al. (2010) | <i>Journal of Technology Transfer</i> |
| Owen-Smith & Powell (2001) | <i>Journal of Technology Transfer</i> |
| Park et al. (2010) | <i>Journal of Technology Transfer</i> |
| Pittiglio et al. (2009) | <i>Journal of Technology Transfer</i> |
| Rasmussen et al. (2006) | <i>Technovation</i> |
| Ratinho & Henriques (2010) | <i>Technovation</i> |
| Resende et al. (2013) | <i>Technovation</i> |
| Salvador (2011) | <i>Journal of Technology Transfer</i> |
| Sanders & Miller (2010) | <i>Science and Public Policy</i> |
| Saragossi & van Pottelsberghe de la Potterie (2003) | <i>Journal of Technology Transfer</i> |
| Schoen et al. (2012) | <i>Journal of Technology Transfer</i> |
| Schoonmaker et al. (2013) | <i>Journal of Technology Transfer</i> |
| Sedaitis (2000) | <i>Research Policy</i> |
| Siegel et al. (2003) | <i>Research Policy</i> |
| Stone (2003) | <i>Journal of Technology Transfer</i> |
| Swamidass (2013) | <i>Journal of Technology Transfer</i> |
| Vohora et al. (2004) | <i>Research Policy</i> |
| Vuola & Hameri (2006) | <i>Technovation</i> |
| Walter (2000) | <i>Journal of Technology Transfer</i> |
| Weckowska (2014) | <i>Technovation</i> |
| Wright et al. (2009) | <i>Journal of Technology Transfer</i> |
| Zi & Blind (2014) | <i>Journal of Technology Transfer</i> |
| Ziegler et al. (2013) | <i>Journal of Technology Transfer</i> |

Theme: Academic Entrepreneurship

Author(s)

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|--------------------------|
| Bathelt et al. (2010) |
| Becker & Gassmann (2006) |
| Beoku-Betts (2005) |
| Bianchi et al. (2011) |
| Chapple et al. (2005) |
| Cooper et al. (2012) |
| Doganova (2013) |
| Ferrary (2008) |
| Festel (2013) |
| Giaretta (2013) |
| Goel & Nelson (2009) |
| Golob (2006) |
| Guerrero & Urbano (2012) |
| Guerrero et al. (2014) |

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| <i>Technovation</i> |
| <i>Journal of Technology Transfer</i> |
| <i>Journal of Technology Transfer</i> |
| <i>R&D Management</i> |
| <i>Research Policy</i> |
| <i>Journal of Technology Transfer</i> |
| <i>Science and Public Policy</i> |
| <i>Journal of Technology Transfer</i> |

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| Hussler et al. (2010) | <i>Technovation</i> |
| Jackson & Audretsch (2004) | <i>Journal of Technology Transfer</i> |
| Johansson et al. (2005) | <i>Journal of Technology Transfer</i> |
| Kidwell (2014) | <i>Journal of Technology Transfer</i> |
| Knie & Lengwiler (2008) | <i>Science and Public Policy</i> |
| Kroll & Liefner (2008) | <i>Technovation</i> |
| Leitch & Harrison (2005) | <i>R&D Management</i> |
| Levie (2014) | <i>Journal of Technology Transfer</i> |
| Libaers (2009) | <i>Journal of Technology Transfer</i> |
| Link & Siegel (2005) | <i>Research Policy</i> |
| Maia & Claro (2013) | <i>Journal of Technology Transfer</i> |
| Markman et al. (2004) | <i>Journal of Technology Transfer</i> |
| Martinelli et al. (2008) | <i>Journal of Technology Transfer</i> |
| Moultrie (2015) | <i>Technovation</i> |
| Nilsson et al. (2010) | <i>Journal of Technology Transfer</i> |
| Owen-Smith & Powell (2001) | <i>Journal of Technology Transfer</i> |
| Patton et al. (2009) | <i>Journal of Technology Transfer</i> |
| Peters et al. (2004) | <i>Journal of Technology Transfer</i> |
| Ratinho & Henriques (2010) | <i>Technovation</i> |
| Rizzo (2014) | <i>Journal of Technology Transfer</i> |
| Roessner et al. (2010) | <i>Journal of Technology Transfer</i> |
| Ruan et al. (2014) | <i>Technovation</i> |
| Salvador (2011) | <i>Journal of Technology Transfer</i> |
| Sanders & Miller (2010) | <i>Science and Public Policy</i> |
| Schoen et al. (2012) | <i>Journal of Technology Transfer</i> |
| Schultz (2011) | <i>Journal of Technology Transfer</i> |
| Sedaitis (2000) | <i>Research Policy</i> |
| Siegel et al. (2003) | <i>Research Policy</i> |
| Swamidass (2013) | <i>Journal of Technology Transfer</i> |
| Vohora et al. (2004) | <i>Research Policy</i> |
| Vuola & Hameri (2006) | <i>Technovation</i> |
| Wright et al. (2009) | <i>Journal of Technology Transfer</i> |

Theme: University-Industry Collaboration

| Author(s) | Journal |
|-----------------------------|---------------------------------------|
| Acworth (2008) | <i>Research Policy</i> |
| Boehm & Hogan (2014) | <i>Journal of Technology Transfer</i> |
| Doganova (2013) | <i>Science and Public Policy</i> |
| Garrett-Jones et al. (2010) | <i>Journal of Technology Transfer</i> |
| Kroll & Liefner (2008) | <i>Technovation</i> |
| Libaers (2009) | <i>Journal of Technology Transfer</i> |
| Martinelli et al. (2008) | <i>Journal of Technology Transfer</i> |
| Morandi (2013) | <i>Journal of Technology Transfer</i> |
| Owen-Smith & Powell (2001) | <i>Journal of Technology Transfer</i> |
| Ratinho & Henriques (2010) | <i>Technovation</i> |
| Resende et al. (2013) | <i>Technovation</i> |

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| Saragossi & van Pottelsberghe de la Potterie (2003) | <i>Journal of Technology Transfer</i> |
| Schultz (2011) | <i>Journal of Technology Transfer</i> |
| Siegel et al. (2003) | <i>Research Policy</i> |
| Thune & Gulbrandsen (2014) | <i>Journal of Technology Transfer</i> |

Theme: Commercialization

Author(s)

Acworth (2008)
 Andersen (2011)
 Bianchi et al. (2011)
 Boehm & Hogan (2014)
 Cho & Lee (2003)
 Derrick (2014)
 Efstathiades et al. (2000)
 Festel (2013)
 Golob (2006)
 Jackson & Audretsch (2004)
 Juanola-Feliu et al. (2012)
 Kidwell (2014)
 Kroll & Liefner (2008)
 Leahy (2003)
 Leitch & Harrison (2005)
 Levie (2014)
 Maia & Claro (2013)
 Malik (2002)
 Matsumoto et al. (2010)
 Moncada-Paternò-Castello et al. (2003)
 Moultrie (2015)
 Nilsson et al. (2010)
 Patton et al. (2009)
 Powell & Moris (2004)
 Rasmussen et al. (2006)
 Resende et al. (2013)
 Ruan et al. (2014)
 Sanders & Miller (2010)
 Saragossi & van Pottelsberghe de la Potterie (2003)
 Schoen et al. (2012)
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 Sedaitis (2000)
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 Ziegler et al. (2013)

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Science and Public Policy
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Journal of Technology Transfer

Theme: R&D and Firm Knowledge Transfer**Author(s)**

Acworth (2008)
Andersen (2011)
Asheim & Isaksen (2002)
Bach et al. (2002)
Backman et al. (2007)
Bathelt et al. (2010)
Becker & Gassmann (2006)
Bessant (1999)
Cho & Lee (2003)
Cruz-Castro et al. (2012)
Daellenbach & Davenport (2004)
Davies & Brady (2000)
Derrick (2014)
Díaz (2012)
Ferrary (2008)
Gallaher & Petrusa (2006)
Garrett-Jones et al. (2010)
Guimén (2009)
Gulbrandsen & Godoe (2008)
Hansen & Ockwell (2014)
Hess & Siegart (2013)
Howells (2006)
Hussler et al. (2010)
Intarakumnerd & Charoenporn (2015)
Juanola-Feliu et al. (2012)
Kingsley et al. (1996)
Lal (1999)
Leitch & Harrison (2005)
Link & Scott (2004)
Malik (2002)
Matsumoto et al. (2010)
Menke et al. (2007)
Moncada-Paternò-Castello & Bellido (2003)
Morandi (2013)
Moultrie (2015)
Nightingale (2000)
Ottosson (2004)
Peretz & Tonn (2005)
Pittiglio et al. (2009)
Powell & Moris (2004)
Rasmussen et al. (2006)
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| Shen (2005) | <i>Science and Public Policy</i> |
| Stone (2003) | <i>Journal of Technology Transfer</i> |
| Vuola & Hameri (2006) | <i>Technovation</i> |
| Weckowska (2014) | <i>Technovation</i> |
| Williams-Jones et al. (2014) | <i>Science and Public Policy</i> |
| Xu et al. (2007) | <i>Journal of Technology Transfer</i> |
| Youtie et al. (2008) | <i>Journal of Technology Transfer</i> |
| Zi & Blind (2014) | <i>Journal of Technology Transfer</i> |
| Ziegler et al. (2013) | <i>Journal of Technology Transfer</i> |