Dutch innovation exodus?

a quantification and characterization of acquisitions of Dutch young technology-based firms with patents by foreign firms

Campfens, T.R.

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A Quantification and Characterization of Acquisitions of Dutch Young Technology-Based Firms with Patents by Foreign Firms

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By Thomas R. Campfens
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Supervisors

prof.dr.ir.ing. R.N.A. Bekkers	TIS, Eindhoven University of Technology
dr. E.M. Tur	TIS, Eindhoven University of Technology
prof. dr. C. Castaldi	Faculty of Geosciences, Utrecht University
ir. H. Helsloot	Senior Intellectual property advisor, RVO

Extended summary

Many developed countries, like the Netherlands, have implemented and created different national and sub-national programs and institutions dedicated to the emergence and growth of innovative firms. However, young and innovative firms are attractive candidates for acquisitions by other firms. Especially in the light of acquisitions by foreign firms, this might result in the migration of economic activities. In turn, this spurs uncertainties regarding domestic appropriation of the benefits of investments in these firms – given the concurrent impact of the acquisition on firm performance and research and development activities (R&D). Currently, there is little known about this type of exit in the context of Dutch firms. Moreover, studies focused on quantifying and characterising these acquisitions are rare.

This thesis takes the focus on studying the acquisition of Young Technology-Based Firms (YTBF), which considers young firms with proprietary technology. The lack of studies focusing on (Dutch) YTBF acquisitions might be due to data availability constraints of young, private and small companies in conventionally used merger and acquisition (M&A) databases. Through utilising recorded changes of ownership of patents, this thesis explores a novel approach to identify and characterise such acquisitions. This is guided by the research question: *How often are Dutch Young Technology-Based Firms (YTBF) with patents acquired by foreign firms, what characterises these events, and what happens with the YTBF thereafter?*

With this focus, the research finds its roots in two distinct research fields. On the one hand, it finds roots in research on acquisitions and the origins of innovation. On the other hand, it is rooted within the research field that employs patent ownership changes. This field has recently gained increasing interest and is in its infancy. Literature and theories from these fields were reviewed as the foundation of this thesis and informed the methodology and analysis to answer the research question.

From the literature regarding acquisitions and acquisitions in the context of the origins of innovation, it becomes apparent that there are equivocal theories, highlighting different narratives for why firms would acquire firms. In line with, for example, the resource-based view, the literature suggests that firms are to a greater and greater extent motivated to source or diversify technological capabilities through acquiring young innovative firms with technology. Additionally, there are multiple rationales for why a YTBF would agree to an acquisition. This equivocality, in theory, is amplified by ambiguity in empirical evidence regarding the impact of cross-border acquisitions from the viewpoint of firm survival and continued innovative performance. It suggests that the economic effects of acquisitions depend on the characteristics and circumstances of the transaction. The literature review informed different avenues for the quantitative analysis.

Additionally, the thesis reviews literature and studies on patent ownership changes. Ownership change of patents can be registered at relevant patent offices. Given the meeting of requirements, a patent office records such a change in a register. These recorded changes, in most cases, include information on the assignor (prior owner) and assignee (new owner) and is paired with an inscription categorising these events. This recorded change is often referred to as an assignment and is the backbone for the methodology and analysis. The review further shows that there are various uncertainties regarding the incentives of registering a patent ownership change, the completeness of assignment data in registers and usage of this data for identifying acquisitions. Given this, the thesis proposes a terminology of acquisitions in the context of assignments. The review further suggests that in the light of cross-border acquisitions recordings of an extensive set of registers need to be considered. Moreover, it is argued that assignment data is prone to a self-selection or self-reporting bias.

The methodology put forward for the analysis takes inspiration from the literature reviews. Here assignment data is filtered, processed and validated to identify Dutch YTBF acquisitions by foreign firms. The methodology combines automatic steps and human intelligence stages. Various indicators are

defined for characterising the involved firms and technology. Amongst these is the overlap in variety of CPC classifications and cross-citations as to define technology relatedness and firm-familiarly. The methodology takes into account the implications of using assignment data. For this, an analysis is outlined regarding the prevalence of assignments recorded by the different patent authorities. Additionally, the completeness of the data is studied.

The results in this thesis are presented according to three sub-questions which (1) consider the number of acquisitions, (2) the characteristics of acquisitions, involved firms and involved technology, and (3) the post-acquisition activities of the firm. Additionally, in line with the implications, analyses were presented on (4) the usage of assignment data.

For the first sub-question, the usage of assignment data resulted in the identification of 19 acquisitions of Dutch YTBFs by foreign firms. For this, around 170.000 assignments were studied, separated by approximately 10.500 different assignor-assignee pairs.

For the second sub-question various characteristics were identified. First, the average (mean) time between founding and first acquisition is 6.9 years. Considering the operating status of the YTBF at the time of the acquisition, this shows that four YTBFs were bankrupt at the time of acquisition. Twelve YTBF have spun or split-off from another entity, of which of eight relate to Royal Philips.

Going back to the supporting of these firms by the Dutch government, it is found that at least fourteen have benefitted from subsidies and loans provided by either the RVO or Regional Development Agencies. Firms are part of two Dutch Top Sectors only; Life Sciences & Health and High-Tech Systems & Materials. For the latter one, this could be related to the dominance of Dutch patent applicants in this sector.

When taking into account the acquirer, the data shows that both America and the European region account for eight out of nineteen acquisition. Additionally, in fifteen cases, it is found that the acquirer was larger than the YTBF in terms of employees. In terms of technology it is found that assignments show that for all cases except one that the acquirer has patents or applications with overlapping CPC classifications as compared to the YTBF. The average overlap of CPC variety is 60.59% on the full CPC's resolution.

Additionally, in 36.8% of cases the YTBF cited the acquirer before acquisitions, whereas the acquirer cited the YTBF in 63.2% of the acquisitions. Lastly, assignments show an overlap between the technologies assigned from the originating firm to the YTBF, and technologies assigned from the YTBF to the acquirer. The average overlap for the twelve YTBF for which this is relevant, is 45.38% on the level of INPADOC families.

For the third sub-question, four YTBFs are re-sold to another firm, and four are terminated. Two YTBFs became truncated firms (only have R&D presence in the Netherlands). From these firms, four originate in Royal Philips. Other firms were integrated, representing different intensities in continuation. When considering the post-acquisition CPC overlap and citations, the following results are found. Overlap on variety in the full CPC resolution decreases in all cases. The thesis discusses different possible reasons for this. For citations, the analysis shows six YTBFs filing, in different intensities, for patents after the acquisition. Of five of these six, it is known that post-acquisition R&D continued. In ten cases the acquirers have filed new patents after the acquisition, which have cited patents of the YTBFs applied for before acquisition. In three cases the acquirers' new filings have cited new filings of the acquired YTBF.

On the level of assignments, most recordings are US assignments. This could be related to the prevalence of the presence of American acquirers. However, when considering all assignments part of an acquisition and those transferred from the originating firm to the YTBF, a noteworthy observation comes forward. For 31 out of these 32 interactions, this included an assignment in the US. Additionally, assignments studied relate to different authorities and inscriptions. These were studied regarding missing

information on assignors and assignees. It was found that almost one-third of the inscriptions represented assignments that had no information on the assignee. Only about one-fourth had no missing information on either of these parties, including US assignments.

Additionally, as a by-product of studying of media outlets for the manual identification of acquisitions, additional acquisitions were identified. Acquisitions identified as such allowed for the studying of the presence of self-selection bias. Here, 18 acquisitions of Dutch YTBFs by foreign firms were identified. For none of these acquisitions, assignments were recorded. For these cases apparently there was either no incentive or legal need to document an ownership change.

The results amplify the ambiguity in literature. Although the analyses highlight different characteristics and the revealed choices of the acquirers, additional cases and information are needed to infer relationships between the firm characteristics, the intentions of the acquirer, the circumstances of these acquisitions and the relationship to firm survival. Additionally, it shows that only utilising assignment data results in a sub-set of actual acquisitions that have materialised. Here the thesis proposes a combination with other data, like trademark assignments and conventional M&A databases, to allow for a more comprehensive overview. Moreover, these additions allow to analyse different aspects of the acquisitions, as well as strengthen various of the introduced indicators. Accordingly, future research is advised to incorporate these.

The thesis complements studies in the field of patent ownership changes and acquisitions, specifically in terms of the usefulness of the methodology to studies that have been unable to differentiate between assignments related to firm acquisitions and stand-alone patent transactions. The introduced methodology allows researchers with a new toolset to single out firm acquisitions. Moreover, the study identifies various shortcoming in the usage of assignment data. Here it is advised to study these further. Lines of inquiry include the incentives to register ownership changes, the standardisation of assignment related data, and how to overcome stated limitations regarding incompleteness systematically.

From a policy perspective, the thesis shows a varied landscape of acquisitions of (revealed) attractive Dutch YTBFs by foreign firms. Given this, policymakers need to define the success factors of the policy tools dedicated to the emergence and growth of innovative firms, while acknowledging the interactions outlined in this thesis, and adjust for these accordingly. This since it is found that almost all firms have received benefits in one way or another. The Dutch government has voiced the importance of the protection of Intellectual Property in its strategy to stimulate the Dutch start-up ecosystem. However, in the light of the studied acquisitions, ownership of intellectual property is transferred to a foreign firm. This protection could prevent the development of future competing products and technologies by Dutch firms within the boundaries of this IP (which might have been the single reason for acquisition). Here the thesis presents two recommendations. One regards the integration of subsidies within the patent system to allow for a better understanding of underlying mechanisms. The second one regards the studying of the feasibility and desirability of different antitrust policies aimed at the acquisition of small or young innovative firms. Currently, the majority of these acquisitions fall outside traditional antitrust boundaries.

Acknowledgements

In the last months, I have acted on a chance to carry out my thesis at *Octrooicentrum Nederland* on an exciting and relevant topic. The identification and characterization of acquisitions of young innovative companies in the Netherlands. When the opportunity for this thesis opened up last year, I was inspired by the proposed use of patent ownership changes as a new method to identify firm acquisitions. This thesis is the materialization of that inspiration. In this process, I was encouraged and supported by many different people, for which I am grateful.

First, I would like to thank my thesis supervisors from the Eindhoven University of Technology. Rudi Bekkers, thank you for the valuable feedback you have provided me throughout the process. You have allowed me to take my own route in the data, explore the possibilities, challenge me, and offered me worthy suggestions. Regarding this exploration of data, with which I was unfamiliar, I want to thank Elena Mas Tur for allowing me to discuss the insecurities I had.

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This thesis marks the final block in the education I have enjoyed during my bachelors and masters at the Eindhoven University of Technology. During this, I have learned about an extensive set of topics and theories related to innovation, something I never want to stop learning about. Thanks to the teachers - particularly those of the schools of Innovation Sciences – who have taught me so much and presented new theories vividly. I am thankful for all the opportunities I have had from the University in this period.

The last thank you goes out to my close friends and family. You allow me to live my life with positivity and gratitude.

Thomas Campfens
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List of acronyms

CBS	Statistics Netherlands (Centraal Bureau voor de Statistiek)
CPC	Cooperative Patent Classification
EPO	European Patent Office
FTE	Full Time Equivalents
IPC	International Patent Classification
M&A	Merger and Acquisition
R&D	Research and Development
RVO	Dutch Enterprise Agency (Rijksdienst voor Ondernemend Nederland)
RDA	Regional Development Agencies
SQL	Structured Query Language
USPTO	United States Patent and Trademark Office
WSBO	R&D tax credit (Wet Bevordering Speur- en Ontwikkelingswerk)
YTBF	Young Technology-Based Firm

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1 Introduction

The Dutch Government, like many other governments (Pires-Alves, Gonzalo, & Lyra, 2019), has implemented and created different national and sub-national programs and institutions dedicated to the emergence and growth of successful (technological) innovations and (young) innovative firms. These include the supporting of business incubators and accelerators, the promotion of academic spin-offs, fiscal incentives for research and development (R&D) personnel and a wide array of loan and subsidy schemes. Following various of these efforts, one of the ambitions voiced by the Dutch government is to become the top European ecosystem for start-ups and scale-ups. In this, the government has voiced the protection of Intellectual Property as a crucial aspect (Tweede Kamer der Staten-Generaal, 2018). Over the last three years, the firms in the Dutch ecosystem have increasingly attracted private funding - from 256 million in 2016 to 557 million in 2018 (StartupJuncture, 2019). This might indicate the success of the ecosystem's attractiveness, emergence and growth performance.

However, young and innovative firms are attractive candidates for acquisitions by other firms. Acquisitions of firms are part of a broader discussion on the source of innovation. For gaining and maintaining competitive advantage, firms continuously try to innovate. Initially, researchers argued that internal R&D is the pivotal source of innovation. However, as discussed in innovation literature, this is only a partial understanding of the firm's success in innovation. In line with the resource-based view, for example, the literature suggests that firms are to a greater and greater extent motivated to source or diversify technological capabilities through acquiring young innovative firms with technology – referred to as Young Technology-Based Firms (YTBF) (Andersson & Xiao, 2016; McCarthy & Aalbers, 2016).

In light of acquisitions by foreign firms, this might result in the migration of economic activities. This, in turn, spurs uncertainties regarding domestic appropriation of the benefits of investments in these firms (Carpentier & Suret, 2014). Various studies discuss the acquisition of firms historically, theoretically or through case studies (see, for example, Carpentier & Suret, 2014; Desyllas & Hughes, 2009; Mohr & Garnsey, 2009). Currently, however, there is little known about this type of exit for the Dutch context, especially regarding cross-border acquisitions and the concurrent impact of this on the firm and related innovative activities. Moreover, studies focused on quantifying and characterizing YTBF acquisitions are rare.

The lack of studies focusing on YTBF acquisitions might be due to data availability constraints of young, private and small companies in conventionally used merger and acquisition (M&A) databases (Andersson & Xiao, 2016). Another possibility to study acquisitions of these YTBF might be employing patent ownership changes. This field has recently gained increasing interest (see, for example, Ciaramella, Martínez, & Ménière, 2017; Gäßler, 2016; Ménière, Dechezleprêtre, & Delcamp, 2012; Serrano, 2010). For the public disclosure of the scope and specification of an invention, the applicant of a patent can receive an exclusionary property right, which can be traded – after which ownership changes. Currently, there is no study exploring the usage of ownership changes of patents for determining firm acquisitions. This is interesting, given that literature suggests that mainly firms with patents are the target for acquisitions (Cotei & Farhat, 2018; Ziedonis, 2004). Ownership changes of patents might provide a vehicle to fill the current void in literature.

1.1 Research questions

The discussion on foreign acquisitions of innovative Dutch firms induces various questions regarding quantification and characterization. This, combined with the proposed usage of patent ownership changes, resulted in the following research question:

RQ How often are Dutch Young Technology-Based Firms (YTBF) with patents acquired by foreign firms, what characterizes these events, and what happens with the YTBF thereafter?

This research question addresses various lines of inquiry. For convenience, the thesis differentiates between three sub-questions. To the best of the authors' knowledge, there has been no quantification in literature regarding Dutch YTBF acquisitions. Henceforth, little one-to-one translatable evidence is prevalent. Therefore, it is crucial to identify how often these acquisitions happen to provide insights into the occurrence of these exits. Given the proposed novel datatype for determining this, it is necessary to define how acquisitions are identifiable through data on patent ownership. These two aspects are the basis for sub-question 1:

SQ 1 How often are Dutch YTBF with patents acquired by foreign firms, and how can this be identified using data on patent ownership?

The involved parties and technology involved in the acquisitions can differ between the acquisitions. Therefore, the second line of inquiry focuses on characterizing the acquisition, the YTBF and the acquiring firm. This is done accordingly to relevant characteristics before the acquisition. Moreover, the technology of the firms and the relatedness could provide additional insights on the acquisition. Here the usage of patents allows studying the underlying technology that is part of an acquisition in more detail. Sub-question 2 addresses this:

SQ 2 What characterizes the acquisitions, the YTBF, the acquiring firm and the technology of the YTBF?

The third line of inquiry focuses on what happens to the YTBFs and the underlying technology after the acquisition. This to obtain a better picture of what happens to the YTBFs and its activities after the exit. Sub-question 3 encapsulates this:

SQ 3 What characterizes the post-acquisition YTBF's activities and the development of the technology?

By answering the three sub-questions, the thesis aims to obtain a detailed overview of the occurrence and characteristics of the acquisitions and involved firms. Additionally, it provides insight into what happens after the acquisition regarding post-acquisition firm performance and technology development. The novel methodology and the unique perspective of the study mean that this study is exploratory. It explores the quantification and characterization of Dutch YTBF acquisitions by foreign firms and the usage of data on patent ownership changes associated with this.

1.2 Conceptualization of Young Technology-Based Firm

Before outlining the thesis, I present a small reflection on what is encompassed by an essential concept of the research question; namely a Young Technology-Based Firm or YTBF (Bobelyn, 2012; e.g. Mohr & Garnsey, 2009; Saemundsson & Dahlstrand, 2005).

Literature differentiates between various concepts for indicating young and innovative firms apart from YTBF. These include *Start-Ups* (e.g. Cotei & Farhat, 2018; Patzelt, Schweizer, & Knyphausen-Aufseß, 2007)*, Young Innovative Companies* (e.g. Czarnitzki & Delanote, 2013; Veugelers & Schneider, 2018) and *New Technology-Based Firms* (Andersson & Xiao, 2016; e.g. Fontes & Coombs, 1995). In general, there is ambiguity regarding the operationalization and definition of any of these concepts, including YTBF. Furthermore, in some cases, researchers use concepts interchangeably. This casts difficulties regarding the comparability of these concepts.

Given the novelty of the research and the ambition to advance understanding with regards to firm acquisitions for the Dutch context, I propose the following focus: young firms that are technology oriented. Technology-orientation is operationalized through proprietary technology. The specific firms are referred to as YTBF because of the technology centrality and age defining character of the concept. Moreover, literature uses the YTBF' patenting activity as a differentiator with *general* small businesses

(Bruneel, Spithoven, & Maesen, 2007; Kim, 2018). Accordingly, the proposed conceptualization is in line with this usage. In more detail, a (Dutch) YTBF it is defined as followed:

1. It is a *young* firm which was maximally 15 years old at the time of acquisition, calculated from its founding date.
2. The firm satisfies one of the following founding types;
    a) Was founded independently
    b) Was founded through a merger of young firms (<5 years old at the time of merger)
    c) Was founded as an independent subsidiary or became independent within three years
    d) Was spun-off/split-off from another company or institution
3. The firm has applied for a patent.
4. Additionally, for Dutch YTBF this is a YTBF which was incorporated or founded in the Netherlands.

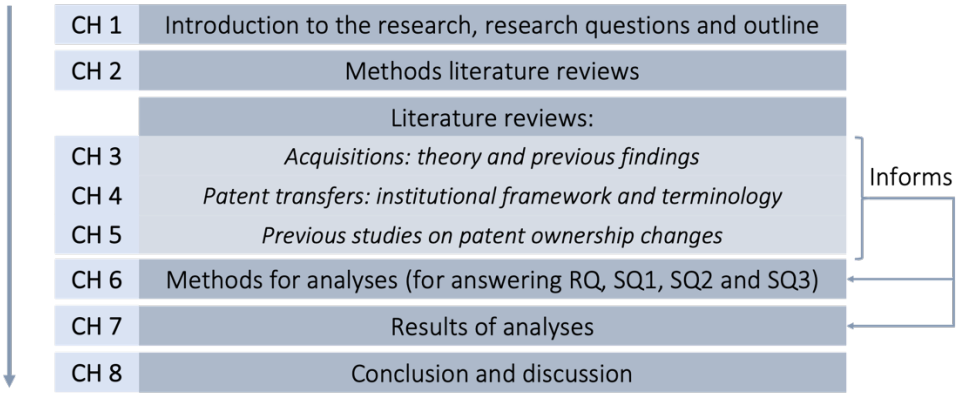
A benefit of the proposed operationalization of technology-orientation is that patent data is openly available in different registers, including information on applicants. This is in contrast to other definitions of innovativeness or technology-orientation, which might be undisclosed, especially for private companies, like R&D spending and the number of R&D employees. Moreover, patents are found in multiple registers and do not rely on self-reported measures of innovation (Stiebale, 2016).

1.3 Thesis setup

Given the ambition of the thesis and the research question, the thesis contains the following chapters. Figure 1.1 shows a visual overview of the structure. Chapter 2 presents a brief methodology for literature reviews presented in Chapters 3, 4 and 5. Chapter 3 reviews both management and innovation literature concerning the theory and findings regarding motivations to acquire and exit. This review provides lines of inquiry for sub-questions 2 and 3 and introduces the theoretical perspectives underlying the research. Chapter 4 introduces the institutional framework of patent ownership changes. It touches upon incentives for reporting such a change and the related procedures at patent authorities. The review includes a reflection on limitations and possibilities for the analysis using the data. *Chapter 5* reviews literature that has utilized patent ownership data and informs other avenues of analysis. These two chapters specifically inform the methodology for sub-question 1.

These literature reviews therefore inform the methodology for answering the sub-questions and research question and is fundamental to the construction of these methods. This is introduced in Chapter 6. These methods are the basis for the analysis. Chapter 7 presents the results of the analyses. Here I reflect upon how this relates to theory and previous findings as presented in the literature reviews. Lastly, Chapter 8 manifests the conclusion and discussion. It contains the reflection on the outcomes of the research, the limitations of the study and methodology, policy recommendations and implications for future studies.

Figure 1.1. Outline of the thesis.



2 Methods literature reviews

This chapter addresses the methodology underlying the reviews for Chapters 3, 4 and 5. These reviews present the theoretical and institutional foundations of the thesis and guide the development of the quantitative methodology and analysis. Furthermore, this allows to position the research within literature.

The study on the acquisitions of YTBFs by foreign firms through analysing patent data is rooted in two main distinct research themes. On the one hand, it addresses acquisitions of firms. On the other hand, it relates to studies using data on patent ownership changes. Within the institutional framework of patent ownership changes, this thesis presents two distinct reviews: one regards the framework itself, and one focuses on reviewing previous studies. Hence, three chapters are presented. The next sections outline the methodology for these.

2.1 Literature review of acquisitions: theory and previous findings

Before reviewing the literature regarding the institutional framework, Chapter 3 first takes a step back and addresses the questions; why would firms acquire other firms, specifically YTBFs? and, why would YTBFs agree to such an acquisition? Moreover, Chapter 3 reviews the literature on the impact of acquisitions, especially from a cross-border context. For this, the chapter reviews literature from industrial organisation (management and entrepreneurship) and innovation theory (sources of innovation). To obtain relevant literature, the search terms "start-up/YTBF acquisitions", "acquisition rationales", "acquisition impact", "cross border acquisitions "and "acquiring innovation" were queried in Scopus and Google Scholar. It was specifically focused on papers that found their roots within popular theories, like the resource-based view and open innovation paradigm.

2.2 Literature review of institutional framework of patent transfers

A fundamental aspect of patents is transferability. Chapter 4 dives deeper into the institutional framework regarding how patent ownership changes are registered and recorded at patent authorities. Recorded transfers are often referred to as patent *assignments*. Chapter 4 reviews the specific framework around these patent assignments, since the framework has recently gained traction but is surrounded by multiple uncertainties. This review is essential for understanding how acquisitions can be studies using assignment data and through this, informs the methodology. The literature reviewed confined a combination of academic literature, governmental documents, patent authorities' websites and other publicly available documentation. These were found by searching for "patent transfers/ transferability" or "patent assignments" through Google Search and Scopus.

2.3 Literature review of previous findings: patent transfers

Chapter 5 reviews studies rooted in the framework reviewed in Chapter 4. With reviewing the literature, the thesis was positioned within this research field, and further implications of utilising patent assignment data were identified. Since the research field is young, finding literature required three techniques. First, literature was looked for using search terms "patent transfers", "patent assignments" and "patent ownership changes" in Scopus and Google Scholar. Second, using the found literature, additional relevant literature was identified by focusing on citations to other documents – known as the snowball method. Third, publications of often cited authors were checked to identify additional relevant publications. Often cited authors included for example Carlos Serrano, Alan Marco, Rosemarie Ziedonis and Alfonso Gambardella. Through this, recently published literature that had received little to no citations, could also be included.

3 Acquisitions: theory and previous findings

This research focuses on acquisitions of YTBFs by foreign firms. Acquisitions reflect a specific form of market selection processes, where established firms purposefully select entrants or other incumbents as acquisition targets (Andersson & Xiao, 2016; Mason & Harrison, 2006). Here, control on all assets transfer to the acquiring or merged company (Caviggioli, De Marco, Scellato, & Ughetto, 2017). Before reviewing the literature to inform the methodology for the research and sub-question(s), this chapter takes a step back; why would firms acquire other firms, specifically YTBFs? Complementarily, why would YTBFs agree to such an acquisition? Here various theories are explored, which provide different narratives. This review provides a theoretical background for the study. Moreover, the literature review regards relevant previous findings for the research and sub-question(s). This is done through consulting both innovation theory and industrial organisation theory. The chapter is structured as follows:

I. Section 3.1 introduces theories on the motivations of firms to acquire other firms.
II. Section 3.2 introduces theory on motivations of a firm to exit through being acquired.
III. Section 3.3 review previous studies on two aspects, namely the characteristics of (a) YTBF acquisitions and (b) cross-border acquisitions.
IV. Section 3.4 reflects on the implications of these reviews for the thesis.

3.1 Acquisition rationales: acquirer's perspective

Why would a firm want to acquire another firm? Answers to this question are diverse and originate in various strands of literature. Innovation and industrial theory provide various specific narratives. These include acquisitions as a means of technology sourcing (Granstrand & Sjölander, 1990), creating synergy gains (Hall, 1987), lowering transaction costs (Williamson, 1987), overcoming obstacles for innovation[1] (Wagner, 2010), building patent portfolios (Park & Panagopoulos, 2019), gaining corporate control[2] (Lichtenberg, Siegel, Jorgenson, & Mansfield, 1987; Manne, 1965) or eliminating nascent competitors[3] (Cunningham, Ederer, & Ma, 2019; Gans, Hsu, & Stern, 2002; Kim, 2018).

Most of the rationales discussed in the literature of acquisitions of firms with patents find their roots within the resource-based view. Accordingly, Sub-section 3.1.1 discusses this in more detail. Sub-section 3.1.2 presents a reflection on when the YTBF's patents or technologies are the single reason for the acquisition.

3.1.1 Theoretical perspectives

Since Penrose's (1959) seminal contribution (Kor & Mahoney, 2004), the academic debates concerning the sources of a firm's competitive advantage have primarily concentrated on the role of resources and capabilities of firms (Barney, 1986, 1991). The resource-based view suggests that a firm's innovativeness is a function of its knowledge base (McCarthy & Aalbers, 2016). While the knowledge base of the firm can be extended internally through, for instance, investing in R&D, this could also be realised by corporate acquisition. In line with this view, literature suggests a greater dependence of firms to source or diversify technological capabilities through acquiring innovative firms (Desyllas & Hughes, 2009;

[1] This body of literature points out that firms may not be able or willing to carry out specific types of innovation. Obstacles for innovation may emerge in the sense that larger firms are unable to carry out specific innovations and or research. However, one could overcome these through acquisitions of other firms, allowing large incumbents to internalise innovation, and hereby substitute internal innovation processes by external acquisitions (Ozcan, 2016).
[2] This theory states that in the absence of active competition, firms are eliminated by the transfer of the control of their assets to superior managers via mergers and acquisitions (Lichtenberg et al., 1987; Manne, 1965).
[3] In support of this view, firms acquire nascent targets with technologies that pose competitive threats, and subsequently shut down the target firm, or its core product, following the buyout. This is exemplified by Cunningham, Ederer, & Ma who argue that firms may acquire innovative targets solely to discontinue development of the target's innovation projects and with this undermine future competition. These acquisitions are referred to as *killer acquisitions* by these authors. In their sample, focusing on the pharmaceutical industry, they find a prevalence of 6% of these acquisitions (2019).

Granstrand & Sjölander, 1990). Moreover, the acquisition allows for the acquirer's potential for inventive recombination (Ahuja & Katila, 2001; Fleming, 2001). Based on this resource-based view, (Öberg, 2016), the paradigm of open innovation (Chesbrough, 2003) argues that it is vital for innovative processes of firms to employ knowledge generated both inside and outside their organisational boundaries (Park & Panagopoulos, 2019).

Both these can be linked to the concept of path-dependency. The knowledge and technologies gained through external mechanisms might be less path-dependent and therefore lead to a greater variance of resource combinations and better innovation performance (Fleming, 2001; Levinthal & March, 1993; Nelson & Winter, 1982).

Recently, authors have tried to combine the resource-based view with the framework of corporate control, a popular narrative in M&A literature. Desyllas and Hughes (2009) distinguish between acquisitions based on a search for inferiority and superiority, either looking for potential turn-around possibilities or as obtaining control over superior innovation performance. Here, the search for superiority is rooted in the resource-based view, whereas the search for inferiority finds its roots in the paradigm of corporate control.

3.1.2 Acquiring innovation

The previous section discussed several reasons for acquisition. An often-voiced rationale in the literature utilising patent ownership changes is that the demand for technology, patents or ideas created by YTBFs may entice incumbents' acquisition of YTBFs (Ozcan & Greenstein, 2013; Serrano, 2010). Hence, YTBF's patents, technologies or ideas might be the single reason for the YTBF to be acquired. Why then would a firm acquire the YTBF instead of the technology or patents? Theoretical perspectives do provide narratives for why acquiring the firm would be a preferred option. For example, transaction cost theory. Although the transfer likely involves a higher cost of acquisition, this might be lower than all related costs regarding adopting the technology, generating know-how, and training employees to deal with the technologies (McCarthy & Aalbers, 2016).

3.2 Exit rationales: Young Technology-Based Firm's perspective

Being acquired is one of the possible *exits* of a YTBF. Other exits include bankruptcy, closure, merging, initial public offerings and various forms of leverage buyouts (Pisoni & Onetti, 2018). Although acquisitions of firms have received vast attention in literature from the perspective of the acquiring party, a substantial smaller body of literature considers the reasons and motivations of firms that decide to exit through this route (Mason & Harrison, 2006; Scott-Kennel, 2012). Within the research on exits, two different levels of analysis are distinguishable; the firm level and the individual level. The coming two sub-sections briefly touch upon the rationales discussed in literature according to these two levels.

3.2.1 Individual level

Exiting on the individual level refers to when founders of privately held firms leave the firm they helped to create (Wennberg & DeTienne, 2014). From the founder's and investor's perspective the most often discussed motivation for exiting is the potential monetary reward (Carpentier & Suret, 2014; Cotei & Farhat, 2018; Mohr & Garnsey, 2009). If an exit through acquisition is the desirable outcome, this might even be part of the firm's strategy. Mason and Harrison voice that most of the assessments of founders and investors exiting fail to consider the positive effect of the cash-out (2006). The post-acquisition behaviour of the cashed-out entrepreneurs could trigger a process of *entrepreneurial recycling*. In this, entrepreneurs use their newly-acquired wealth and accumulation of experiences, to engage in other entrepreneurial activities. Potentially materialising in the starting of new business ventures or investment in other businesses as business angels (Mason & Harrison, 2006).

However, Carpentier and Suret (2014) find that this might be an exception rather than the standard. Based on 14 case studies, these authors find that only a small proportion of bought-out entrepreneurs reinvests in the local economy. Moreover, Kim (2018) reports that the propensity of acquired workers to launch a new company in the same original industry is significantly lower in case

the target had patented. The employees that exited might be less inclined to start new businesses within the boundaries of that intellectual property.

3.2.2 Firm level

On the firm level, literature discusses different rationales. Scott-Kennel (2012) argues that the acquired firm's rationale to sell addresses the gaps in existing activities and resources that are required for further growth. In line with transaction cost theory (Williamson, 1987) acquiring necessary assets for growth by the YTBF might be more costly than having the whole innovation process integrated into another firm with a completer set of resources available. Additionally, Graebner and Eisenhardt (2004) find that sellers are pushed toward acquisition by attractive buyers offering synergistic-combination potential. In turn, the acquisition is a means to achieve growth through the synergistic integration of the activities and resources of the two firms (Seth, Song, & Pettit, 2000). The latter is in line with the view of synergy gains (Hall, 1987) and the resource-based view (Barney, 1986). Other explanations include the strengthening of the bargaining position in future takeover deals (i.e. a more extensive patent portfolio) (Park & Panagopoulos, 2019) and as a first opportunity to access public capital (Cotei & Farhat, 2018).

3.3 Young Technology-Based Firm acquisitions: characteristics and impact

To the best of the authors' knowledge, there has been no quantification with regards to Dutch YTBF acquisitions by foreign firms[4]. Hence there is no, or little, one-to-one translatable evidence available. Therefore, this section reflects upon findings found in neighbouring literature. Sub-section 3.3.1 presents a brief literature review regarding the characteristics of acquisitions of young firms. The second Sub-section, 3.3.2, addresses theoretical predictions and empirical evidence regarding the impact of the acquisition on post-acquisition firm survival and innovative performance.

3.3.1 Characteristics of Young Technology-Based Firm acquisitions

One characteristic of acquisitions that comes forward in literature is the timing of the event. Bruno and Cooper (1982) reported a mean age of 6.4 years for 81 *high-technology firms* that were acquired. Additionally, Pisoni and Onetti (2018) studied the strategies of acquisitions and exits in the US and Europe. They suggested that both European and US acquirers prefer to buy early-stage start-ups (age of 0-5 represented 36% of the acquisitions, 29% for 6-10 and 25% for 11-16). It seems to suggest that the older the firm, the lower the probability of being acquired. However, Holmes and Schmitz (1995) find no conclusive evidence as to how the sale of active businesses depends on its age.

A second characteristic is a match between the acquirer and the acquiring firm. In line with the resource-based view, Ahuja and Katila (2001) show that the relatedness of the acquirer and target knowledge bases have a substantial impact on the subsequent innovation output of the firms. In this, the authors focused on the size of the knowledge base, which is operationalised by (a) all patents applied for by a firm and (b) the patents these documents cite to (referred to as backward citations or cited documents). The relatedness of the knowledge bases then is defined by the overlap of the cited patent documents. Implying that the focus is on the size of the knowledge base and only considers qualitative overlap of the prior art.

[4] However, the general survival of young innovative and Dutch firms was studied (e.g. Audretsch, Houweling, & Thurik, 2000; Cefis & Marsili, 2006). Audretsch and colleagues analysed the survival rate of Dutch manufacturing *start-ups* (defined by the number of employees) and concluded that 85% survived two years compared to 45% surviving a decade (2000). These authors did not quantify to what extent the decline in survival was due to acquisitions. For their analysis, the authors used a longitudinal dataset from Statistics Netherlands (CBS). The CBS still publishes datasets including information on acquisitions. However, this data is anonymised and aggregated. Moreover, there is no possibility for breaking down the data on the nationality of the acquirer and the age of the acquired party. Hence analyses regarding the research question are impossible. Data can be obtained from the website of the CBS under 'bedrijven'.

3.3.2 Cross-border acquisition: post-acquisition survival and innovative performance

Theory and empirical evidence are ambivalent and equivocal regarding what extent foreign acquisitions lead to a reduction, advancement or relocation of innovation activities of the acquired firm (Scott-Kennel, 2012; Stiebale, 2016). This section briefly reviews theories and previous findings.

3.3.2.1 Theory

From a *resource-based view of the firm*, one could argue that cross-border acquisitions may lead to increased innovative performance since previously not available routines now might be freely accessible within or between the firm(s) (Feys & Manigart, 2010; Stiebale, 2016). Additionally, it allows to combine complementary firm-specific assets not available in the home countries of the YTBF or acquiring party (see, for example, Nocke & Yeaple, 2007). On the other hand, from the *synergy gains perspective,* Feys and Manigart argue that given cultural differences, synergies may be more challenging to implement in cross-border acquisition compared to domestic acquisitions (2010). Moreover, transaction cost theory suggests that geographic distance between the firm and its target increases transaction, monitoring, agency and asymmetric information costs, while at the same time reducing the benefits of soft information (McCarthy & Aalbers, 2016; Williamson, 1987).

3.3.2.1 Previous findings

It is uncertain to what extent acquisitions fulfil its promise as a business opportunity beyond immediate investor returns (Desyllas & Hughes, 2010; Mohr & Garnsey, 2009). Studies that look at the effect of acquisitions on the R&D process (e.g. Danzon, Epstein, & Nicholson, 2007), the output (e.g. Prabhu, Chandy, & Ellis, 2005) as well as the financial performance of the firm (e.g. Cosh & Hughes, 2008) consistently present negative impacts on post-acquisition performance. Additionally, various case studies highlight the termination of the innovative activities of the acquired firms after the acquisition. For example, Pires-Alves et al., who looked at how start-up acquisitions should be interpreted from an antitrust perspective, find that acquisitions often imply termination of those businesses (2019). Complementarily, Carpentier and Suret (2014) found that post-acquisition activity of Canadian *start-ups* was limited. Often these firms were truncated, denoting firms with only an R&D function. These lack head offices, sales and finance functions that potentially generate significant economic activity.

However, other literature highlights the benefits of acquisitions in the light of access to foreign distribution channels (Guadalupe, Kuzmina, & Thomas, 2012), export networks (Blonigen, Fontagné, Sly, & Toubal, 2014) or country-specific capabilities such as marketing expertise (Nocke & Yeaple, 2007). For example, Lindholm Dahlstrand (2017) reports that for the Swedish context, foreign acquisitions of *start-ups* have a positive effect on economic performance. Interestingly, she argued that this might be related to the post-acquisition autonomy of the acquired firm.

Interestingly, in line with transaction cost theory, McCarthy and Aalbers hypothesised that the physical distance between the target and acquiring firm predicts the post-acquisition innovative performance of the merged firm. Borders they argue, interrupt the flow of information, imply cultural and institutional complications, influence negotiations, and imply various costs, delays and disruptions. Specifically, for technology these authors argued that the costs implied by geography may be amplified. However, their empirical data shows the opposite; for acquisitions involving technology, foreignness can be more of an asset than a liability (see McCarthy & Aalbers, 2016, especially page 1821). Other proximities beyond geographical distance (i.e. social, organisational and institutional) could also be relevant for differences in post-acquisition performance (see, for example, the seminal work of Boschma, 2005).

3.4 Summary and implications for the research

The previous subsections introduced theories on the rationales of acquisition and exit, briefly reviewed the literature on the characteristics of the acquisitions and reviewed studies on the post-acquisition survival and performance of these firms. Here I reflect upon this and what this implies for the research.

First, there seems to be ambiguity in the literature regarding the impact of cross-border acquisitions from the viewpoint of firm survival and continued innovative performance. The economic effects of these acquisitions seem to depend on the characteristics and circumstances of the transaction (Ahuja & Katila, 2001; Carpentier & Suret, 2014; Mason & Harrison, 2006). The ambiguity might be rooted in the limited knowledge of the characteristics, context and economic impact of the acquisition of locally owned YTBFs by foreign firms.

Second, the review highlights different types of post-acquisition continuity of the YTBF. From the perspective of the acquiring firm, a YTBF can be integrated, truncated, terminated, or one can keep the independence of the YTBF. Integration refers to when a firm integrates the YTBF's activities within their activities. The studies on the Swedish and Canadian start-ups shows that it is essential to take this into account. The intention of the acquirer regarding the post-acquisition integration or continuation of the YTBF might be a crucial indicator for the concurrent performance and or integration of the firm. However, there is little research with regards to this topic. Possible reasons include difficulties in determining the acquirer's intentions before acquisitions and the trustworthiness of self-reporting of these intentions. Hence it is advised that for sub-question three this aspect is considered through not only looking at the technology development, but also at the continued actives of the acquired YTBF. This provides insights into the revealed choices made by the acquiring party.

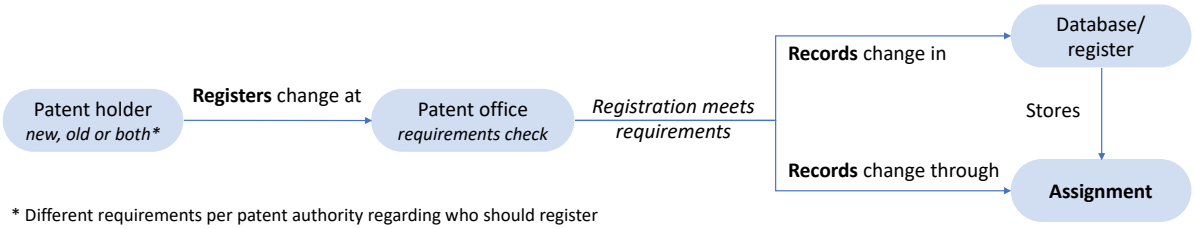
Additionally, the characteristics discussed in Sub-section 3.3.1 inspire the analysis. Specifically, given the focus on the size of the knowledge bases rather than the qualitative differences, I introduce novel methods to determine the technology match between the acquirer and acquired firm and hereby inform an answer to sub-question 2.

4 Patent transferability: Institutional framework and terminology

One of the fundamental characteristics of patents is that ownership of it can be transferred. Important to note is that applications or patents can be transferred more than once. As a tradable property right, ownership of patents is transferred for various economic reasons (Gäßler, 2016; Ziedonis & Hall, 2001). This includes stand-alone assets sales or transfers part of a firm acquisition (Ahuja & Katila, 2001; Serrano & Ziedonis, 2018). Here the latter option is of particular interest for the research question and sub-questions. In case a YTBF is acquired, the acquiring firm obtains the shares of the YTBF. When this happens, the acquiring firm could have reasons to also transfer the rights of the intellectual property of the YTBF. Moreover, given the institutional framework surrounding patents, there could be possible incentives for registering these changes at patent authorities.

In the pursuit of exploring these incentives and the usage of patent ownership changes in the context of acquisitions, I first want to make an essential distinction between three aspects. First, the possible ***registration*** or communication of ownership changes of patents by the right holder of these patents at a patent office. Second, in case the ownership change is registered at the patent authority this could, in case the authority's requirements are met, lead to a ***recording*** of this change in the office's register or database. Third, this specific data stored in the different databases and registers is often rereferred to as an assignment or conveyance. This assignment is the data that allows the studying of registered and recorded patent ownership changes. Hence, literature refers to the registration and recording of an *assignment*. Figure 4.1. presents a visual overview of this distinction.

Figure 4.1. Registration of ownership changes and recording of the change through an assignment.



Given this distinction, the chapter is structured as follows:

I. Section 4.1 first explores what the reasons might be for transferring patent rights, and what the incentives are for *registering* such transfers at patent offices. Moreover, it introduces the procedures relevant for registration of patent ownership changes.
II. Section 4.2 discusses how the registration of these ownership changes leads to the *recording* of this information in different registers. It touches upon the differences between patent offices in recording and storing of these changes. This section also introduces the characteristics of the assignment data and how it is relevant for the research.
III. Section 4.3 introduces, based on the discussion in Sections 4.1 and 4.2, new terminology for the usage of assignments (recorded patent ownership changes) in the context of acquisitions. Consequently, this clarifies what acquisitions are and informs the analyses.
IV. Section 4.4 summarizes the chapter and discusses the implications for the research.

4.1 Registration of ownership changes: procedures and incentives

Why would a firm that acquires another firm register ownership changes of patents? This fundamental question for the research is the focus of Sub-section 4.1.1. Given the findings in Sub-section 3.3.2, this sub-section differentiates according to different cases regarding the post-acquisition integration of the YTBF. It is important to acknowledge that this discussion focuses on patent assignments as part of acquisitions, rather than a discussion of the incentives to document changes of ownership in case a single patent or bundle of patents is transferred. Subsequent sub-section 4.1.2 discusses the requirements of registering a patent ownership change at patent offices and differences between these offices.

4.1.1 Incentives for registering patent ownership changes

If a YTBF is acquired, the shares of the YTBF are transferred to the acquiring party. However, there are different situations possible regarding the transferring of other assets, which depend on how the acquiring party deals with the post-acquisition integration of the YTBF. As was discussed in 3.3.2, there are different options here. Regarding differences in post-acquisition integration, the first sub-section introduces possible legal incentives. The subsequent section introduces other incentives.

4.1.1.1 Legal incentives

To the best of the author's knowledge, in case the YTBF is kept as an autonomous or truncated firm after the acquisition, there is no legal need to register a change of ownership. This since the acquiring firm acquired the shares of the YTBF and became the legal owner of the YTBF and its underlying assets. However, other incentives could be relevant (see 4.1.1.2).

In case the YTBF is integrated and subsequently is closed, liquidated or terminated, there are two incentives for registering ownership changes of patents from a legal perspective. First, regarding the enforceability of the property right against third parties. This differs between countries as there are differences in laws regarding enforceability and ownership changes. An international survey by the International Association for the Protection of Intellectual Property Rights in 2006 encompassed 44 countries' individual responses with regards to this uncertainty[5]. Some countries reported the requirement of registration of assignments to confer rights against third parties for these patents. This is especially relevant given the fact that applications or patents can be assigned more than once. In a hypothetical case, where a firm is sold to two different firms (without these two firms knowing about it), there could be multiple conflicting registered and recorded assignments. In some countries the first who registers the assignment is the rightful holder of the patent (Ciaramella et al., 2017). This discussion suggests that if an assignment goes unrecorded, the assignor could transfer a patent to a subsequent purchaser, and so long as that subsequent assignment was recorded, it would take priority. Consequently, this means that the recording of the assignment protects the patent owner against previously unrecorded interests and subsequent assignments.

Moreover, Chesbrough argues that in the light of maintaining the patent and paying the relevant fees, keeping ownership information is essential. Hence, and combined with enforceability, this is another legal incentive for firms to register ownership changes (2006).

4.1.1.2 Other incentives

There is little research on incentives of registering patent assignment outside the legal domain. Here I aim to propose a brief overview of possible incentives, which could be relevant also in case legal incentives are not applicable. For example, the acquirer could want to manage all of its intellectual property by a centralised entity (i.e. an IP holding) within the mother firm and hence transfer ownership accordingly. This centralisation, in turn, offers the combining of patent assets for licensing packages and easier management of the intellectual properties. Additionally, a centralised patent portfolio offers possibilities for an enforceable centralised patent stock, especially considering litigation (Park & Panagopoulos, 2019; Scott Morton & Shapiro, 2013). Moreover, another incentive could be that the acquiring company wants to register assignments for reasons of status and prestige, through an enlarged patent stock.

4.1.2 Registration of patent ownership changes: procedures and differences

So, when an acquiring firm has reasons to register a patent assignment, it can do this at a relevant patent office it wants to update this information. Depending on where a patent has been granted or applied for, different patent offices might be relevant for registration. There are different requirements and procedures for different authorities. To retrieve the most up-to-date and specific information regarding

[5] According to the survey of in case only patents are transferred, and no firm was acquired a second legal incentive holds the validity of the transaction between parties. All the publications can be conveniently found at: https://aippi.org/committee-publications/?committee-id=7418

these procedures, I refer to the websites of these respective patent authorities. For example, both the United States Patent Office's (USPTO) and the European Patent Office's (EPO) websites show the requirements for registration of an ownership transfer. On a general level, most offices demand an original or duly certified copy of the official document containing the deed of transfer of title of the patent by the proprietor. Additionally, based on a survey by LexMundi (2012)[6], there are little to no requirements regarding the period for recording such a change at patent authorities. Moreover, the costs related to registration differ substantially between these patent authorities (Gäßler, 2016).

Interestingly, with regards to the registration of changes in Europe, Ciaramella and colleagues (2017) note that assignments of European patents need to be centrally registered up to grant. However, after grant, an assignment can only be registered centrally during the opposition period or during opposition proceedings.

4.2 Recording of ownership changes: procedure, differences and data

A registration leads, in case the requirements of a specific patent office are met, to a recording of the ownership change in the register of the office. This recording often includes information on the change in ownership, the date, and the *assignor* (the prior owner) and *assignee* (the new owner) (Chesbrough, 2006; Graham, Marco, & Myers, 2018b) – hence the stored data is referred to as an assignment. An assignment is often paired with an inscription that characterises the type of recording, either as additional information within the assignment or as a separate field of information. The subsequent data that is recorded, which encompasses the transfer of full ownership to another party and the inscription, can be used to study ownership changes. It is important to note that this is not the same as a license to a patent (Nicolas Figueroa & Serrano, 2013; Scott Morton & Shapiro, 2013). Stored data can be retrieved through various means, different for various patent authorities. The methodology elaborates on this.

So, stored data in registers allows for the studying of ownership changes. However, there are various aspects to consider. First, the use of inscriptions is not standardised, nor are there unified inscriptions for specific natures of ownership changes. Second, the same inscriptions and assignments are used to document different other categories of *events,* like name changes or registration of security interest. Third, assignments are published to correct mistakes made during recording or registration (see e.g. Chesbrough, 2003; Ciaramella et al., 2017). Fourth, there are differences in speed in which these are published, as well as how (fast) these are integrated into the centralised European register (European Patent Office, 2019a; Eurostat, 2013). Fifth, for the European patent application procedure (see 4.1.1), subsequent ownership changes (might) need to be registered at different offices. The latter results in the coexistence of recordings in different registers, leading to parallel events across national registers.

4.3 Assignments and challenges associated with the sequence of events

The previously mentioned characteristics of the institutional framework have implications regarding how to use the data in the context of an acquisition. So, in the case recorded data is obtained, how can these be used to study acquisition as opposed to other natures for patent transfers? Most important here is the aspect of determining the sequence of events in the data, which is shortly elaborated. Given this discussion, I propose a definition for acquisitions from the perspective of assignments.

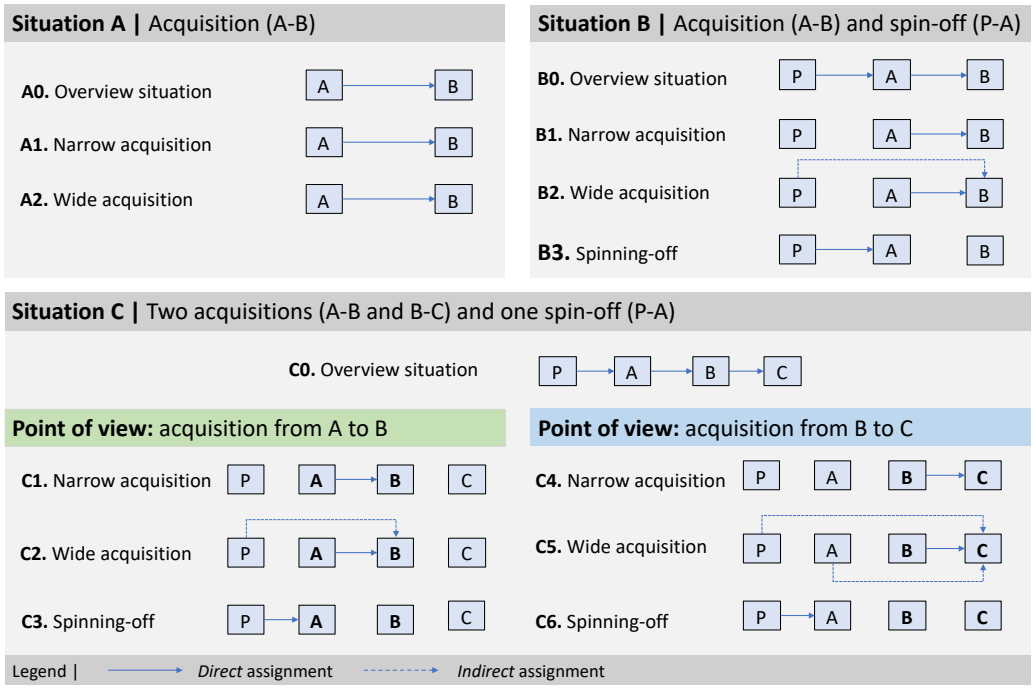
Regarding the sequence of events, I introduce a hypothetical scenario before outlining the implications. Here the focus is on patents historical chains of title, which refers to the sequence of historical transfers of ownership over the lifetime of a patent (Graham et al., 2018b). One might capture an assignment of a patent from party A to B, and a separate assignment of another patent (or same patent in a different register) from party A to C, but lack any reassignment from B to C. Given the often voluntary nature of registrations, this needs additional information to corroborate the data and define if there might be a missing link. For example, an unregistered transfer between B and C. In case

[6] LexMundi is a network of independent law firms. These surveyed different authorities regarding the period in which transfers should be registered and the consequences of such failure. Not all patent authorities were surveyed.

corroborating evidence pronounces that firm A was acquired by firm B, which was subsequently acquired by firm C, this means that there is indeed a missing link in these patents chain of title. A more complicated scenario comes to mind when A has spun-off from parent firm P and has obtained various patents form P. This means that there are even more potential couples for the assignments (P to C for example). Additionally, conflicting and different information could be available in different registers.

This discussion shows that two critical aspects of assignment data are the possible links between firms and the likelihood of unregistered changes. Hence, it is necessary to corroborate data and determine a proper sequence and chain of events. However, even with a proper sequence of events, there is uncertainty regarding what assignments to study in the context of acquisitions and technological relatedness? Specifically, for spinning-off, the specific assignments are crucial for understanding the origin of specific technology and patents. Moreover, from the perspective of acquisitions, multiple patents could be involved with different chains of titles. Hence what does this mean for interpreting the various possibilities of ownership transfers in the chain of title of patents for acquisitions? Figure 4.2 presents three scenarios regarding the different possibilities of links between firms that are part of a chain of events.

Figure 4.2. Assignments: spinning-off, the wide and narrow acquisitions perspective. *Own elaboration.*



Here I propose a distinction between a *narrow* and *wide* acquisition perspective for using assignments, considering the various possibilities of *direct* and *indirect* assignments between firms that are part of a sequence of acquisitions, mergers and spin-offs. This taxonomy is fundamental to the methodology and analysis.

Given (a) corroborating evidence for various firm related interactions, (b) acquirer N, (c) acquired party K and (d) a sequence S with length L of subsequent interactions (merger, spin-off, acquisition) in the lifecycle of firm N with other firms $\{A, \dots, K, N\}$, I define the narrow and wide acquisitions perspective from the perspective of acquisition $K - N$ as follows[7]*:*

- A **narrow** perspective includes all assignments that have N as the assignee and the previous owner $K = N - 1$ as the assignor and $L \geq 2$.

[7] Situation C shows that it is crucial to include the perspective of which acquisition is under examination for the operationalisation of the wide versus narrow acquisition definition.

- A **wide** perspective includes all assignments that have N as the assignee and any of the identified parties in the preceding sequence of events as an assignor ($N \notin S$) and $L \geq 2$.

Consequently, this distinction focuses on the firm level rather than the patent level, as it is assumed corroborating evidence for transfers of patents is more challenging to retrieve. Therefore, it should be noted that the operationalisation of both the narrow and wide acquisition perspective could take into account patents part of other interactions between the firms as opposed to the acquisition. In case corroborating evidence is available for this, one could control for these specific patents. The proposed distinction is fundamental for analysing and understanding the use of assignments.

4.4 Summary and implications for this study

The previous sections reviewed the incentives for registering ownership changes and the procedures for registration and recording. Moreover, Sections 4.1 and 4.2 introduced assignment data and Section 4.3 presented a critical implication for the usage of this data in the context of acquisitions. The latter resulted in the proposing of the narrow and wide acquisition perspective. Based on the review in this chapter, two important implications for this research come forward. Namely, (1) the completeness of assignment data and (2) using assignments in studying cross-border acquisitions.

4.4.1 Limitations regarding the completeness of assignment data

The completeness and comparability of assignment data is an important implication for the research. First, *assignments* and the accompanying inscriptions of patents could have the same form whether they refer to stand-alone patent transaction or are part of firm acquisitions. Meaning that corroborating evidence is needed to define the underlying economic activity related to assignments. Additionally, data is needed for establishing a proper chain of events for the firms (Section 4.3).

Second, there is uncertainty regarding the need to register changes, although there could be various incentives (Sub-section 4.1.1) which are often voluntary. Consequently, assignment data is prone to a self-selection or self-reporting bias. In other words, only firms inclined to register changes can be seen in assignment data (Graham et al., 2018b). This has implications for drawing conclusions regarding studies using this data.

4.4.2 Implications of studying cross-border acquisitions using assignments

In the light of cross-border acquisitions and uncertainties regarding incentives of the acquirer to register changes at specific offices, this means that recordings of different possible registers need to be considered. Given that there is no study focusing on these incentives and best practices for research, it is beneficial for this study to consider as much available assignment data from a more extensive rather a more modest set of patent offices. Furthermore, this provides insights on how to study Dutch YTBF acquisitions from the perspective of assignment data and which patent authorities are worth considering for future studies.

5 Previous studies on patent ownership changes

The previous chapter discussed that ownership transferability is a fundamental characteristic of the patent system and that *assignments* are used to record these changes in various registers (which in turn have different inscriptions in different registers). Gäßler (2016) notes that several national patent offices have been systematically registering patent ownership changes since as early as the 19th century. Strikingly, as he argues, this is in marked contrast to the rather burgeoning academic interest in patent transfers. Research utilising this data has only materialised within the last which two decades. In this chapter, I briefly review this research field utilising patent assignment data and reflect upon relevant previous findings. This review allows for the positioning of the thesis in the context of previous research rooted within the same institutional framework. This chapter has the following structure:

I. Section 5.1 provides a brief overview of the focus of research using patent assignment data.
II. Section 5.2 presents relevant previous findings based on a literature review on the studies using patent assignment data. This review informs the methodology and analysis.
III. Section 5.3 then addresses the positioning of the thesis.

5.1 Overview of literature

Within the literature field that uses patent assignment data, an important distinction can be made based on the temporal focus (Gäßler, 2016). Some studies use historical accounts of assignments during the late 19th century and beginning of the 20th century. Other studies focus on contemporary assignment data of the last decades. According to this distinction, this chapter presents an overview of these studies and their focus.

5.1.1 Historic accounts

The literature that studies patent assignment data originates in the work by Lamoureaux and Sokoloff (1999a, 1999b, 2001). These authors used a sample of sales of private inventor patents (1870-1911) and provided a historical account of whether organised *markets for technology* existed (Appendix A). They find that the trade of patents is frequent and might infer specialisation of independent inventors. Later this was complemented by the research of Nicholas and Shimizu (2013) who report similar findings (1886-1926). Burhop (2010) studied patent ownership changes in Germany (1884-1913) and found substantial differences between transfers rates in Germany and the US. Burhop and Wolf (2013) find, based on the same dataset, that distance and borders have negative effects on the trade of patents. Andersson (2014) studied ownership changes of Swedish patents (1871-1914) and finds that a legislative change towards a stronger patent regime led to an increase in patent transfers.

5.1.2 Contemporary accounts

Studies focusing on contemporary accounts of assignments are rooted in the works of Serrano and Chesbrough (Chesbrough, 2006; Serrano, 2005). Serrano (2006) developed a dataset of US patent assignment (1980-2001) and utilised this to study the economics of intellectual property transfers. Chesbrough (2006) explored the emerging secondary markets for intellectual property by looking at both US and Japanese recorded assignments.

Both these studies sparked interest in future studies utilising assignments, most prominently utilising USPTO's patent assignments. This includes studies that looked into assignments for measuring the market for technology in an industry (Mani & Nandkumar, 2016), inventor surplus (Nicolas Figueroa & Serrano, 2013), security agreements of start-ups for collateral (Hochberg, Serrano, & Ziedonis, 2018), the relation between litigation of patents and earlier events in the patents' life (Chien, 2012) and the relation between externalising innovation and concentration of patents (Ozcan & Greenstein, 2013). Additionally, papers by Galasso et al. (2013) and Serrano (2018)[8] quantified the gains from patent trading, in terms of patent enforcement and comparative advantages for small firms.

[8] Previously mentioned in the literature under (Serrano, 2011) and other preliminary publications.

Complementarily, recently, studies have been published that utilise European based patent assignments. The main reason for this is the publication of a legal status database in PATSTAT on patent ownership assignments registered at more than 20 patent offices since its September 2010 version (Gäßler, 2016). PATSTAT is the worldwide patent statistical database created and maintained by the European Patent Office (EPO). Given this availability, researchers started investigating European patent assignment data. Ménière and colleagues (2012) were the first and focused on assignment data of patents granted by EPO or the French Patent Office. Gäßler (Gäßler, 2016) followed with research on Germany (Gäßler, 2016). Moreover, a master thesis focused on Sweden (Gustafsson & Lodén, 2018). Additionally, Ciaramella, Martínez and Ménière (2017) tackled the issue of tracking transfers at the European level. Interestingly, this study explicitly excluded Dutch assignments. The authors argued that there is uncertainty regarding the need to register transfers[9].

Other studies have used small-scale datasets. These studies looked at patent transactions of particular actors in the market for technology (Fischer & Henkel, 2012) and the impact of patent characteristics on the likelihood of stand-alone transactions (Messeni Petruzzelli, Natalicchio, & Garavelli, 2015). These last authors report that organisations tend to acquire patents with a narrow scope and report that the number of scientific references has a U-shaped impact on the likelihood of patent acquisition.

5.2 Relevant findings of studies utilizing patent assignment data

The previous section highlighted the rise in research using assignments. Within this research field, most studies utilising patent assignment data focus upon stand-alone or bundled patent transfers as evidence for the trade in patents in the markets for technology, patents and ideas. In exceptional cases, the focus is on the acquisitions of firms. *Appendix A introduces and discusses the markets for technology, ideas and patents.* Although this research specifically focuses on acquisitions and the related assignments, three themes come forward that provide relevant lines of inquiry for the research. These are (1) the occurrence and timing of assignments, (2) the characteristics of assigned patents and assignees, and (3) assignments in the context of cross-border interactions.

5.2.1 Assignments: occurrence and timing

Two important aspects of the institutional framework are the number of assignments recorded and the timing of registrations during the lifecycle of the firm. These might provide additional information on the differences between the various offices.

Chesbrough (2006) illustrated the growing number of recorded assignments in the US and Japan. In 1980 fewer than 2,000 assignments were recorded in the US while nearly 90,000 in 2003. For Japan, this grew from 5,000 in 1997 to 35,000 in 2005. Researchers have also studied how much percentage of patents were assigned at least once over their lifecycle. Serrano (2010) finds that 13.5% of all granted US patents are assigned at least once. Ménière and colleagues (2012) show that 6.7% of all patents granted by EPO or the French Patent Office and validated in France are assigned at least once. These authors find that only 1.4% of patents are assigned between independent parties. These transactions are referred to as bare interactions, which happen between two independent firms. Hence, these are of interest to the research. In turn, Gäßler (2016) finds that about 7–8% of all patents applied for at the EPO or the German Patent Office and validated in Germany are transferred in arms' length transactions[10]. Interestingly, Ozcan and Greenstein (2013) find that M&As result in the transfer of 11% of the patent stock in the US ICT equipment industry.

Second, Serrano (2010) was the first to study the occurrence of an assignment over the lifecycle of a patent. The probability of patents to be (re)-assigned was found to monotonically decreases over the lifecycle, excluding for those months just before a patent renewal fee was due. As was outlined

[9] Here the authors do not consider patents only validated in the Netherlands but do include patents which validated in any of the other countries used in their analysis.

[10] This is complementary to the use of bare transaction by (Ciaramella et al., 2017)

ownership changes often do not have to be registered within a specific timeframe (see 4.1.2), but this highlights the propensity to register such assignments in the lights of fees. This finding, therefore, supports the argument that these fees are an incentive to maintain an updated assignment register (see 4.1.1). Similarly, De Marco et al. (2017) hypothesised that new owners who reveal their willingness to pay maintenance fees on the acquired patents would also possess a stronger motivation to record the reassignment, finding the effect while reporting caution due to possible censoring effects.

5.2.2 Characteristics and context of assigned patents and assignees

Various studies have looked at the characteristics of the patents and assignees involved in assignments. Serrano (2010) showed that the probability of a US patent being assigned depends on its characteristics: younger and more frequently cited patents are more likely to be assigned. Additionally, he finds that patents that have recently been (re-)assigned have a higher propensity to be reassigned.

Similarly, the author also finds that the characteristics of patentees influence patents' rates of transfer—small innovators and private inventors assign more patent than larger ones. In this publication, Serrano voices an important implication for this thesis. Namely, he is unable to distinguish assignments that are related to the acquisition of a (small) firm from assignments related to the acquisition of a bundle of or single patents. In a later study, Figueroa and Serrano (2019) focus on a potential concentration of patent ownerships by large firms due to transferability but find no evidence for this. The authors do find that small firms disproportionately acquire and sell more patents than large firms. They focused solely on stand-alone transactions in the market for patents and did not incorporate firm acquisitions, which in the light of concentration might be a significant limitation.

A study by Caviggioli and colleagues (2017) is the only (known to the author) publication that distinguishes between the characteristics of patents assigned either originating in M&A or the market for technology. The authors argue that patents assigned in the market for technology seem to protect less complex, and thus, easier to trade, technology. Moreover, they argue that smaller teams of inventors develop these inventions and that a higher technical merit characterises these. Regarding patents that are assigned through M&A, these are characterised by more tacit knowledge. In sum, the authors argue that technology acquired in the market for technology can be incorporated in the portfolio of activities in an easier way than those from M&A processes.

New research by Serrano and Ziedonis (2018) studied the ease of redeployment of patent assets after a failed innovation attempt (i.e. bankruptcy). Their study indicates that patents are potentially reassigned after bankruptcy and might lead to the appropriation of rents for investors.

5.2.3 Assignments and cross-border transfers

Two studies studied assignments in a cross-*border* context. Drivas and Economidou (2015) studied assignments on the level of US states to explore whether geographic factors *within* the same country confine the trade of weightless ideas. Their results indicate that geographic proximity (distance and contingency), influences patent assignments. The authors argue that geographic proximity does not proxy transportation costs for *weightless* ideas (as opposed to physical trade of goods) but act as an informational barrier[11].

Similarly, De Marco et al. (2017) studied cross-border patent transactions (2002-2012) and tested the effect of the geographical origin on US patent transferability and timing. Coherently with the idea that cross-border transactions might be affected by more significant barriers, they report that patents with a first non-US original applicant have less probability of being assigned and take longer to be assigned. It should be noted that both these studies did not focus on firm acquisitions, and hence it is unknown to what extent the findings can be translated to the scope of this thesis.

[11]Interesting follow-on research could take into account different types of proximity as highlighted for example in the publication of (Boschma, 2005), to define in more detail the origin of these barriers.

5.3 Positioning of the research and implications of previous findings

In the previous two sections, I presented a review of the literature that utilises the institutional framework introduced in Chapter 4. Additionally, the chapter provided various previous findings that might be relevant to this thesis. Here I reflect upon these and discuss the implications for this research. Through this, the thesis is positioned within the research field.

First, most of the studies that utilise assignment data focus on the markets for technologies, ideas and patents. This focus is different from the thesis' focus on acquisitions. There is uncertainty in literature how these concepts relate. Assignments related to acquisitions could prove the transferability of intellectual property rights, ideas and technology. However, it is ambiguous how this proves the functioning of the markets for technology, ideas and patents. Here opposing views are put forward in literature[12]. In line with the research question, this thesis focuses on acquisitions. It discussed that patents, technologies and ideas could be the single reason for the acquisition (see Section 3.1). This thesis refrains itself from further discussions on this ambiguity, besides proposing caution regarding the translatability of the discussed studies to the context of acquisitions, as these studies have focused on different economic activities.

Relatedly, multiple researchers voiced being unable to differentiate between assignments related to firm acquisitions and stand-alone patent transactions, especially for small firms. Some authors argue this is related to the underrepresentation of small and private firms in the commonly used M&A data, which are used to filter these out (see, for example, Serrano, 2010). Hence, this amplifies uncertainties regarding what extent the findings in this literature review can be translated to the context of acquisitions. The thesis complements previous studies by putting forward a novel methodology (Chapter 6), and through this, allow researchers with a new toolset to single out firm acquisitions. Additionally, this might have implications for the current research field in terms of, given this inability, overestimations of patent transactions in the market for technology (Appendix A).

Furthermore, it becomes apparent that there is currently no research that identifies the acquisitions of firms through analysing patent assignment data. Although the publication by (Caviggioli et al., 2017) touches upon assignments related to acquisitions, it is necessary to note that these authors started from a sample of acquired firms and analysed the related assignments. In this thesis, the focus is on using assignment data to identify acquisitions.

Lastly, although the research interest and output concerning patent assignments are growing, most of the research is still heavily focused on US data. In line with the review, this leads to one specific recommendation for the methodology. It might be beneficial to consider a more extensive rather than a select set of patent authorities' assignments. This data allows studying the revealed choices of acquiring firms to register changes at specific registers.

[12] Gäßler (2016) argues that it is unreasonable to infer to what extent market forces are driving firm acquisition without considering whether the gain of patent ownership is the main objective or merely a consequence. Contrary, the survey by Caviggioli and Ughetto (2013) shows that the main reasons for transferring patents within these markets are that these are part of a more complex business arrangement like firm acquisitions. Chesbrough (2006) argues that in a true secondary market for patents, these patents should be traded without bundling them with underlying businesses.

6 Methods for analyses

This chapter introduces the method to answer the research and sub-question(s). In Chapter 2, the methods for the literature review were outlined. These reviews have provided various lines of inquiry and implications for the research. Hence, the thesis confines a mixed-methodology approach, which combines a literature review and a quantitative data analysis. This chapter introduces the latter one, according to the following structure:

I. Section 6.1 introduces the steps undertaken to quantify Dutch YTBF acquisitions by foreign firms, providing the method for answering sub-question 1.
II. Section 6.2 outlines how this data is used and coupled with other data for characterising the acquisitions, the involved firms and the technology-relatedness of the firms. This section provides the methodology for answering sub-question 2.
III. Section 6.3 introduces the methodology regarding sub-question 3. It provides methods to determine post-acquisition technology development and firm survival.
IV. The last section, 6.4, presents the methodology regarding the usage of assignment data, which informs further research and the validity of the study.

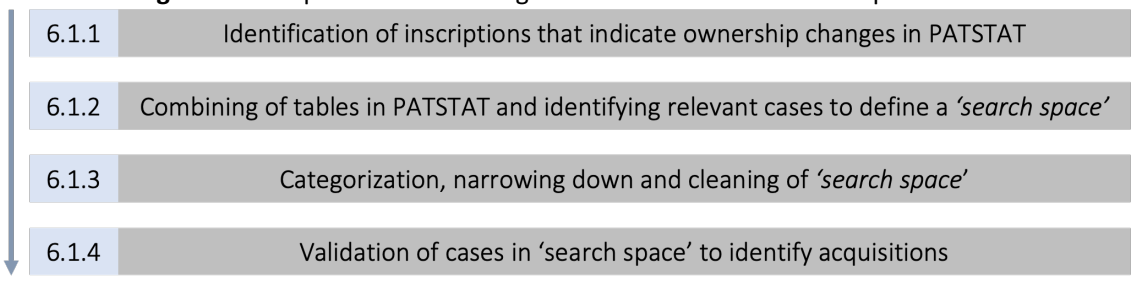
6.1 Quantifying acquisitions using patent assignment data

To answer a part of the first sub-question, *how often are Dutch YTBF with patents acquired by foreign firms?* this thesis utilises and explores the use of patent assignment data. Chapter 4 argued that various patent offices record these assignments in their registers. So how can this data be retrieved and used to answer the research and sub-questions? Chapters 4 and 5 highlight that for studying cross-border acquisitions, it might be beneficial to study a comprehensive set of assignment data that spans the recordings of various patent authorities. This since there is currently no knowledge of best practices.

In this pursuit, the PATSTAT Database comes to mind. PATSTAT is the worldwide patent database created and maintained by the EPO. PATSTAT has an extensive scope and includes data on EPO and US assignments (European Patent Office, 2019a). Moreover, is a relational database which allows for the combining of information stored in different tables (which can be combined through *keys*).

So, this sub-section discusses how data from PATSTST is retrieved, processed, harmonised and validated. This informs an answer to the first sub-question. Figure 6.1 presents the structure for this section, which differentiates multiple steps. These steps are briefly introduced below, after which the next sub-sections discuss each step's methodology extensively. The obtained data serves as input for Sections 6.2-6.4, which address the methods and analyses for answering sub-questions 2 and 3.

Figure 6.1. Simplified overview of general method to answer sub-question 1.



Assignments are recorded in different registers paired with different inscriptions. Therefore, relevant inscriptions were identified, as well as how the related assignments could be retrieved from PATSTAT. Sub-section 6.1.1 discusses this extensively. To retrieve and select the information to answer the sub-question various tables needed to be combined. As PATSTAT contains lots of information within its database, the relevant cases were defined, which resulted in a search space. Sub-section 6.1.2 dives deeper into this. Given differences in recording and formatting of assignments, data was processed. This processing included steps for additional categorisation to identify only relevant cases and data-cleaning to ease the validation phase. Sub-section 6.1.3. discusses this. Lastly, due to the limitations of patent

assignment data for identifying acquisitions, the data was validated to define if an acquisition had taken place. This validation phase included both automatic and manual steps. Sub-section 6.1.4 outlines this.

Before outlining these steps, a few remarks relevant for the remainder of this chapter regarding PATSTAT are made. When referring to PATSTAT, this is the 2018 autumn version. With regards to all aspects regarding the usage of PATSTAT, this refers to SQL (Structured Query Language). SQL is a language that enables the managing and processing of data in relational databases. For reference purposes, Appendix B lists all the discussed PATSTAT tables and codes. Here the tables include additional information on these elements. When referring to a PATSTAT table in the text, these names are shortened to their identifying number only, for readability purposes. Appendix B lists the full name of these tables.

6.1.1 Identification of inscriptions that indicate ownership changes in PATSTAT

Before working with assignments, it was essential to define which inscriptions were relevant. Ownership changes of patents are recorded in different registers and paired with different inscriptions (Chapter 3). In PATSTAT these and other inscriptions are referred to by means of an EVENT_CODE. Table TLS803 includes information on these and their description. This table lists approximately 4000 event codes, sorted by the EPO into 21 different overarching groups. Category *'R'* (EVENT_CATEGORY_CODE) is of particular interest since it groups events related to the recording of changes in party data by the competent patent office (EVENT_AUTH) (European Patent Office, 2018). By limiting to this category, 292 potential event codes were identified. The descriptions of these codes were manually checked to determine if these referred to changes in ownership, as opposed to for example name changes. The omitting of non-relevant codes was done conservatively, so no potentially relevant classifiers would be lost. This process led to the inclusion of 96 codes for the remainder of this study, from 29 authorities. Appendix C provides an overview of these, grouped by event authority. Importantly, only the conjugation of the event authority and event code is unique.

6.1.2 Combining of tables in PATSTAT and identifying relevant cases to define a 'search space'

The second step was to retrieve relevant data from PATSTAT. PATSTAT contains a wide set of patent-related information in various tables. Within these tables, PATSTAT stores data in different attributes. Here one can *filter* or *query* information according to the possible values these attributes can take. So, using the relevant filters and combining tables, a table could be created that includes information on the relevant cases. This table will be referred to as the '*search space'*. Given the sub-question and the possibilities of PATSTAT, this table was defined by considering all patent applications (national, EPO and PCT) and related patent publications of Dutch companies (where a Dutch company is an applicant) which were assigned through an assignment. This means information was needed regarding applications, publications, applicants and assignments (Kang & Tarasconi, 2016). This information could be coupled and retrieved by combining tables TLS201, TLS211, TLS227, TLS206[13] and TLS231. TLS201 includes relevant information regarding an application, TLS211 information on publications, TLS227 an identifier for the applicant of a publication, TLS206 information of the applicant and TLS231 assignment data. By combining these tables and selecting the relevant cases for the attributes, this defined the search space:

A. To limit to applicants and not inventors[14]: setting APPLT_SEQ_NR > 0 for table TLS227
B. To limit to Dutch applicants: setting PERSON_CTRY_CODE[15] as 'NL' for table TLS206
C. To limit to companies: setting PSN_SECTOR = 'COMPANY' for table TLS206
D. To limit to inscriptions that indicate ownership change only the EVENT_CODEs part of Appendix C were considered and set for EVENT_CODE = [*such a code*] for table TLS231

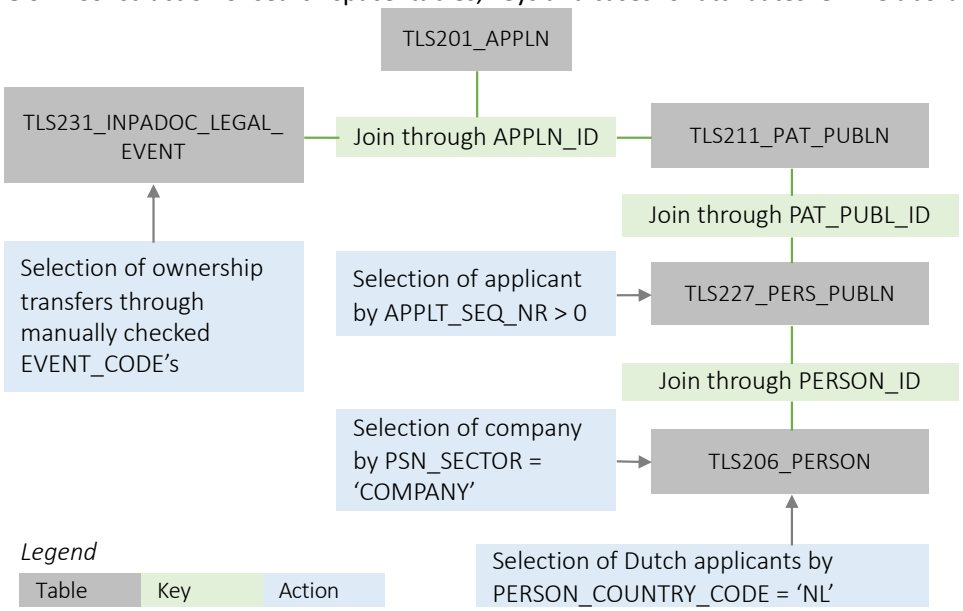
[13] It should be noted that TLS207 was not used since this only corresponds to the information available for last publication associated with an application (de Rassenfosse, Dernis, & Boedt, 2014), hence TLS227_PERS_PUBLN was favourable option given it holds information for each publication.

[14] Given the research question inventors are not of interest, but the potential firm related to these.

[15] Various authors argue that this variable indicates the location of the owners of the invention (de Rassenfosse et al., 2014; Pasimeni, 2019)

Figure 6.2 visually presents the coupling of tables and the respective limiting to specific cases. This overview includes the keys through which these tables were coupled. The resulting table or *search space* contains information on applicants, the bibliographic information of the (applied)patents, the related publications and information on the patent's assignment. The specific interest in this table is on the assignor (PARTY_OLD) and the assignee (PARTY_NEW) as well as the occurrence of these pairs. This initial version of the *search space* serves as the basis for the subsequent parts of the methodology.

Figure 6.2. Construction of search space: tables, keys and cases for attributes. *Own elaboration.*



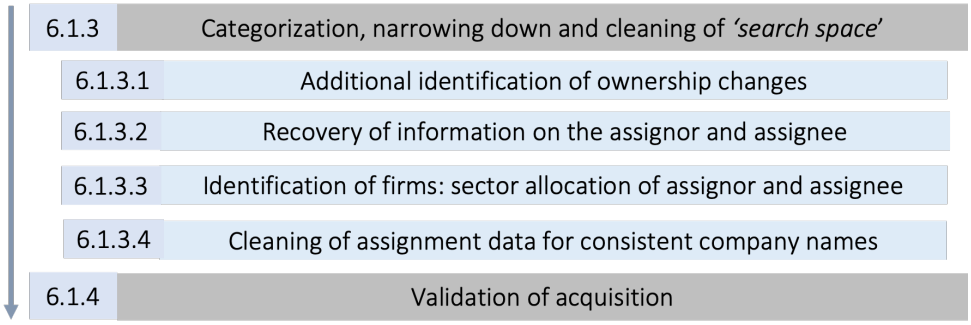
6.1.3 Categorization, narrowing down and cleaning of *'search space'*

With the defined initial *search space*, additional operations were performed before the information was subject to validation. This was based on characteristics of the data and possibilities of PATSTAT.

I. In some cases, the formatting of the recorded assignments offered the opportunity to categorise assignments and narrow down further to ownership changes of patents part of specific transactions.
II. Sometimes assignments are missing the assignee or the assignor. In some cases, other information available in PATSTAT was utilised to *recover* this information.
III. PATSTAT allows to filter companies for applicants but does not offer this for the assignee and assignor. Here I outline the usage of a sector allocation algorithm to allow for this.
IV. To ease validation inconsistencies in the formatting of assignments, spelling mistakes and legal forms were cleaned and harmonised.

The coming sub-sections elaborate on these aspects. Figure 6.3 provides a visual outline of the structure.

Figure 6.3. Cleaning and narrowing down of the initial search space.



6.1.3.1 Additional indicators of ownership change

Two essential attributes of the search space are the attributes with information on the assignor (PARTY_OLD) and assignee (PARTY_NEW). These attributes hold information in a string, which allows for the storing of a sequence of characters. These strings were often unstructured and included different information from office to office. For US assignment the PARTY_OLD string included information on the nature of the assignment [16], like the *hint* "merger". Hints provided opportunities to categorise assignments further and drop non-relevant cases.

For this categorization, assignments were allocated and grouped in five categories of different conveyance types: (1) transfer of ownership, (2) an administrative event, (3) judicial related event, (4) security interest related events and (5) other assignments. This categorisation was inspired by other studies (Graham et al., 2018b; Alan Marco, Myers, Graham, Agostino, & Apple, 2015; Serrano, 2010). The algorithm I developed classified the assignments according to hints in the string that infer membership of a specific category. These hints were defined by manual checking of the data. After a multitude of iterations, approximately 250 rules for hints were defined, assigning membership to a specific group, while minimising membership overlap. Appendix D provides examples of these rules and hints.

6.1.3.2 Recovery of information on the assignor and assignee

Sometimes all information on assignors and assignees was provided in either a PARTY_OLD or PARTY_NEW string, while the other was empty. Then, in some cases, information stored allowed to recover information with regards to who was the assignor and assignee. One example is [entity] *'transfer to'* [entity] in PARTY_OLD. The information before this was set as the assignor, whereas the information after was set as the assignee. Similar cases for either direction were considered and programmed.

However, some entries did not have any information in PARTY_OLD, nor could it be recovered from the PARTY_NEW string. Here I assumed that whenever this was the case the applicant's name should be considered as the assignor[17]. Cases were PARTY_NEW was empty and could not be recovered were not considered, since a similar assumption could not be made for the assignee.

6.1.3.3 Identification of firms: sector allocation of assignor and assignee

The research question addresses the acquisitions of firms. PATSTAT includes a (partially) *harmonised* name and sector allocation of applicants in table TLS206, which was used to define the search space. However, PARTY_OLD and PARTY_NEW cannot be linked to this information. Ergo, I developed a procedure that used clues in these attributes to define if an entity was a firm. However, these attributes were cleaned first, regarding information used in the previous two sections as well as often recorded address information. The legal form of firms was not cleaned as this is a crucial clue for the sector allocation procedure. The focus in this step was on defining clues and cases that infer membership of the sector *firm/company* versus clues that infer a clear non-membership.

The research of Magerman, Looy and Plessiss (2006) inspired this procedure. These authors describe their effort to harmonise patent data through sector allocation. Their methodology aims at maximising the number of generic rules that translates clues found in patentee names into pre-defined sectors. These clues could be parts of firm names (like '[] *and sons'*), parts of specific words (like '[] industries' and legal forms (like Inc.). However, using these rule-based clues only assigns a selected set of firms. Since firms might not have such clues in their firm names or the specific legal form could miss in the assignment. Hence, the authors complemented these rules by case-based allocation criteria to increase accuracy and completeness. This includes cases that were not assigned through the rules, but clearly resemble a firm (like IBM) (Van Looy et al., 2006). Here I defined additional rules and cases by running the authors; code and checking non-assigned entries. Appendix E lists all additions, which includes explicitly clues for Dutch firms and cases of Dutch companies (like NXP). Additional cases and

[16] For the patent's offices in Europe I expect that information is better integrated into the PATSTAT environment.
[17] By assigning the PSN_NAME (the version of the harmonised name in PATSTAT without legal form information).

rules were expected as the names in PARTY_OLD and PARTY_NEW not necessarily have to be part of TLS206, nor is quality of these string guaranteed.

After various iterations of defining rules and cases, I assumed that entities that were not assigned any sector were a company. This conservative decision was made given research constraints. Additionally, I deviated from Looy et al. (2006) with regards to overlapping sector allocations for similar reasons. Therefore, parties all entities allocated to the company sector were considered[18], whereas all entries allocated to another sector but not to the *company* sector were filtered out.

6.1.3.4 Cleaning of assignment data for consistent company names

To smoothen validation, information on assignees and assignors was harmonised. Here the emphasis was on cleaning information through a set of rules[19] and hereby achieve partial unification (Caron & Daniels, 2016). Non-relevant data on name variations[20], spelling mistakes and legal forms were harmonised or removed. This provided a more consistent overview of various assignor-assignee pairs. More specifically, an iterative algorithm was developed which (1) replaced multi spaces with a single space, (2) removed trailing commas, (3) removed legal forms (informed by 6.1.3.3), (4) removed non-alphanumeric characters at the end and beginning of the strings, (5) corrected spelling mistakes, (6) harmonised common words, and (7) removed information behind commas (i.e. address information). Legal forms, spelling mistakes and common words were included based on running various iterations and subsequent manual checking of the cleaned strings.

6.1.4 Validation of cases in *'search space'* to identify acquisitions

With cleaned data on assignors and assignees, the assignment data could be used to identify acquisitions of Dutch YTBF by foreign firms, and thereby answer sub-question 1. Here various procedures were undertaken to narrow down the search space and drop all assignments that were not a proxy for an acquisition. As was argued, assignments are embedded in very distinct contexts, and the inscriptions used by the authorities do not unify under the thesis' ambition. This was done in two steps (1) an algorithm that filters out intragroup pairs and (2) a manual procedure that checked all non-intragroup pairs to determine if the assignments were a proxy for an acquisition of a Dutch YTBF by a foreign firm. Importantly, acquisitions can correspond to multiple pairs given name variations and partial harmonisation.

6.1.4.1 Automatic intragroup filtering

Based on the sector allocation, only those interaction between exclusively firms were kept. However, the remaining interactions could still be between the same companies given name differences, subsidiaries and the made assumption. An algorithm was developed to automatically filter out of these intragroup interactions. This algorithm used the names of the assignor and assignee for both perfect-name matching and an approximate string similarity-matching. Table 6.1 provides examples of cases filtered out through these two different matching techniques.

Table 6.1. Cases filtered out through perfect and string-similarity matching.

Type of matching	PARTY_OLD	PARTY_NEW
Perfect string matching	Philips Electronics	Philips Electronics
	Unilever	Unilever
String similarity-matching	Philips Electronics	Philips Gloeilampenfabrieken
	Unilever Patent Holdings	Unilever

[18] For example, 'Utrecht University Holding' was both assigned as a company and a university. This because of the two conflicting clues *University* and *Holding*. Given its allocation, to the sector 'company' this entity was considered.
[19] As opposed to for example the research by (Magerman et al., 2011), who focus on the unification through a more elaborate scheme of algorithmic operations.
[20] Large companies often have many name variants, for example, Royal Philips has several hundreds of name variants in the PATSTAT Database (Caron & Daniels, 2016).

The perfect string-matching algorithm filters out those cases were PARTY_OLD and PARTY_NEW are identical. The string-similarity matching uses the SQL SOUNDEX function, which is a phonetic algorithm that indexes names by sound, as pronounced in English. The SQL DIFFERENCE function allows determining the difference between the SOUNDEX score of two strings. Given this algorithm focus', there are potential false positives. False positives are interactions identified as intragroup by the algorithm, which in reality are not intragroup. For example, a slight difference in the name could be the result of an acquisition. Alternatively, the two names are not that similar in reality[21] and do not denote the same *company*. After different settings of the algorithm and human intelligence stages, I minimised the number of false positives. The algorithm used the minimal DIFFERENCE for determining intragroup transfers. Given the number of pairs and research constraints, a sample rather than the whole population was checked regarding possible false positives. From this, it is inferred that the defined algorithm marked most intragroup transfers correctly. Hence, I assumed the algorithm filtered out *intragroup* interactions appropriately. After this, transactions defined as intragroup were excluded. However, to also control for false negatives (those transactions that are intragroup but not identified as such) the manual validation outlined in the next section also incorporated validation regarding intragroup interactions.

6.1.4.2 Manual validation

Various steps were needed to define if assignments between two firms were related to an acquisition. For this PARTY_OLD and PARTY_NEW were combined into one string and were grouped for identical pairs. Using descending ordering a list of the highest to lowest observed pairs obtained. These pairs were subject to an iterative manual procedure to determine if the observed pair was related to an acquisition of a Dutch YTBF by a foreign firm. Given the number of pairs, the manual validation differentiated between two different subsets, presented in Table 6.2. The decision to differentiate between two samples assumed that pairs with more observations might be related to firm acquisitions rather than single or bundled patent transactions. However, as YTBFs might have a limited number of patents (and unclear incentives for registration), it was decided to consider less observed pairs strategically.

Table 6.2. Definition of subsets and procedure for manual validation

Subset	Definition of subset	Manual validation intensity
1	Pairs $\geq$ 10 observations	All pairs are validated
2	Pairs 1-9 observations	Stratified sample of 5 random pairs for each number of observations

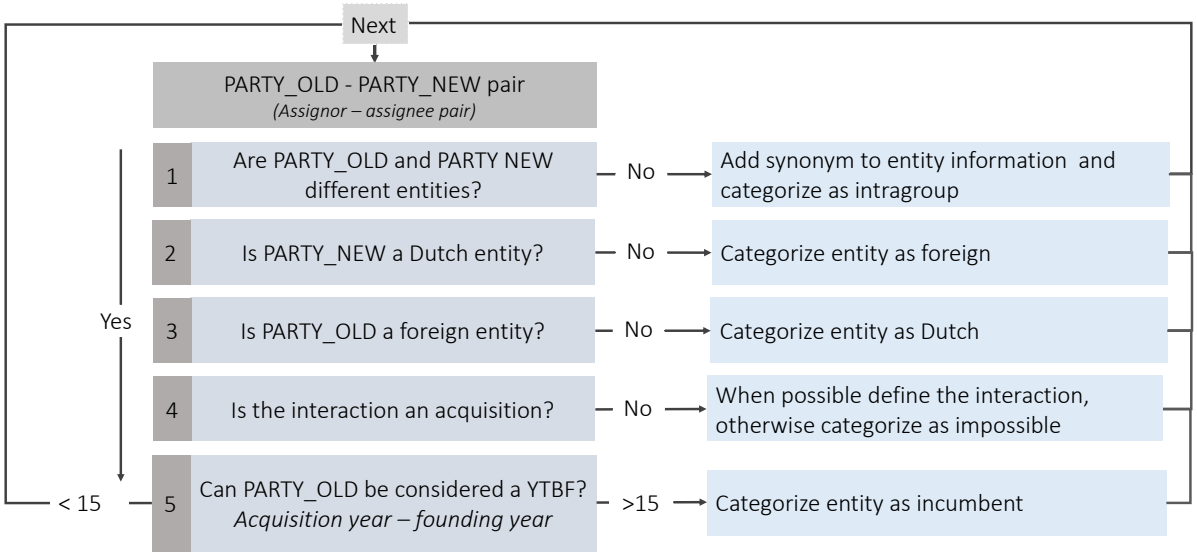
The manual procedure was structured according to five questions. These were used to determine the relation of the found assignment to an acquisition of a YTBF by a foreign firm. Figure 6.4 (next page) presents these questions and the structure of the validation. Since the dataset is longitudinal and covers different periods, the age of the firm was normalised by the difference between the acquisition date and founding date. Additionally, although the search space was determined by focusing on Dutch applicants only, these could also be Dutch holdings of a foreign firm. These were filtered out.

The information needed to answer the *questions* was found using a variety of sources. Regarding firm information, companyinfo.net and LexisNexis were used. For M&A information CrunchBase and Index from The Next Web were checked. Gäßler argued that data coverage in such databases correlates with firm size and deal volume (2016). Information on corporate structures and activities of small firms is less likely to be present in external business registers. Hence, Google Search, Delpher[22] and respective company websites were consulted for additional data on the founding year, nationality and possible acquisitions. For this, I queried the names of the companies (or synonyms) in conjunction with the word acquisition (or *overname* in Dutch) in Google. Only the first three pages of hits were considered.

[21] Interestingly most of the false positives included Dutch last names that included Van (e.g. Van Lith). Most of these cases represent names of individuals rather than companies end were filtered out in a previous step.

[22] Delpher is a free website providing full-text Dutch-language digitised historical newspapers, books and journals.

Figure 6.4. Manual procedure for identifying relevant acquisitions. *Own elaboration.*



After retrieving the relevant information for subset-1, all pairs that could not be related to a Dutch YTBF acquisition by a foreign firm were dropped[23]. Given the information on an extensive set of pairs and related parties, this affected the number of observations and pairs of subset-2. Therefore, only hereafter subset-2 was considered. Here a random stratified sample was validated by the same manual procedure. This sequence allowed for a higher quality of the stratified sample by reduction of noise.

6.2 Characterization of acquisition, firms and technology-relatedness

Based on the validation, a sample of Dutch YTBFs that were acquired was identified. This section outlines how additional information was gathered, processed and analysed to answer sub-questions 2. This question addresses the characterisation of the acquisition, the usage of the institutional framework, the YTBF, the acquiring firm and the technology. This section is structured accordingly.

6.2.1 Characterization of acquisition: deal value, operating status and timing

The characterisation of the acquisition included the operating status of the YTBF at the time of the acquisition, the timing of the acquisition over the lifecycle of the YTBF and the acquisition deal value. The deal value was considered as it can be considered a proxy for the value of the firm, including its tangible and intangible assets, and the attractiveness of the YTBF. Moreover, it allows putting into perspective the acquisition. Additional information was retrieved to characterise the acquisition regarding these aspects. In case it was publicly disclosed, the deal value and date were defined based on information available in annual reports (through companyinfo.net), news updates, and M&A information from Index and CrunchBase. Combining the founding and acquisition date of the YTBF, the speed of acquisition was defined. Additionally, in line with findings by (Chondrakis, Serrano, & Ziedonis, 2019) regarding the redeployment of patents after bankruptcy, it was looked at the operating status of firms at the time of acquisition. Information was collected through openly available data from firm websites, news websites, blogs, archived newspapers through Delpher and annual reports.

6.2.2 Characterization of involved parties

For putting into perspective the acquisitions, the involved parties were characterised. For this additional information was retrieved. The acquirer was characterised according to its nationality (as derived in 6.1.4.2) and economic power or size. Regarding economic power, it was defined if the acquirer was listed on a stock exchange at the time of the acquisition. This was found using Google.

[23] In case there was no corroborating evidence for an acquisition, nor for other interactions, it was not considered further.

Previous studies have often focused on the acquiring firm. However, here efforts were made to focus on the perspective of the YTBF. Hence, the YTBF was characterised according to a broader set of characteristics. These included the receiving of subsidies, membership to a specific industry, membership to a Dutch Top Sector, a description on the activities of the YTBF and the location of the legal/statutory seat. Regarding the information on received subsidies, Dutch subsidies from the Dutch Enterprise Agency (RVO) and Regional Development Agencies (RDA) were considered. Regarding industry, the *Standaard Bedrijf Indeling* (SBI) was used. The SBI is a hierarchical classification of economic activities that classifies business units according to their main economic activity (Kruiskamp, 2019). This SBI 2008 version was translated to SBI 1993[24], which allowed defining the number of patent applicants in these categories through the study of (de Heij & Kuipers, 2010). These authors determined the number of patent applicants at the Dutch patent authority and EPO in the period 2000-2006 for entities classified according to SBI version 1993. The study by (de Heij & Kuipers, 2010) did not include analyses regarding the overlap of applicants at these two authorities, which is assumed to be relevant.

Moreover, the SBI was used to derive if a firm is part of one of the 9 Dutch Top Sectors. For this, the methodology outlined in (CBS, 2017, 2018) was relevant. This categorisation was useful for generalising the companies according to overarching sectors and provide recommendations. Moreover, this allows for comparisons with previous research on patent applicants and applications of Dutch firms within these Top Sectors by (Snoei, van der Linden, & Seip, 2013). Regarding the size of the YTBF before the acquisition, information was used to categorise the YTBF as small (1-10fte), medium (11-100fte) and large (>100fte). The usage of categories was used because of different data sources and data availability. FTE refers to full time-equivalents. Information on the description of activities and the legal seat were retrieved from information in annual reports and archived websites closest to the date of acquisition.

Through validation, the acquisition of the YTBF was found (narrow acquisition). However, additional events could have taken place within the lifecycle of the firm, which is essential for both the context of the acquisition and firms. Here noteworthy events include spinning-off and prior or subsequent acquisitions. The search space was used to define these possible events and the corresponding sequence. Here the names of the acquired and acquiring party were set as assignee and assignor to retrieve other registered transfers of patents by these parties (wide acquisition). In order to corroborate these events, an identical verification step as in sub-section 6.2.4.2 was undertaken.

6.2.3 Characterization of technology

On the level of technology, two different characteristics were considered. These are the (1) origin of transferred technology, and (2) how the technology of the YTBF related to the technology of the acquiring party. This section deals with the pre-acquisition period and only those applications with an EARLIEST_FILING_DATE[25] before the acquisition date were considered.

6.2.3.1 Technology origin of the Young Technology-Based Firm

In terms of the origin of the technology, assignments allow a unique perspective for analysis. As was discussed in Chapter 4, there are possible pairs between firms that are part of a sequence of events. So, by utilising assignments between firms, one could analyse the potential overlap between various flows. For example, looking at the origin of the technology of the YTBF, I determined the overlap between (I) patents assigned as part of the potential spinning-off before the acquisition (set A) and (II) patents assigned part of a subsequent acquisition (set B). This overlap revealed unique information on the origin of the technology and incentives of the acquirer for the acquisition. Overlap of sets $(A\ and\ B)$ was calculated using equation 1. This calculation was performed on the level of patent families to analyse the origin of technologies as opposed to a specific patent. For families, the INPADOC _FAMILY_ID was used (Jacob, 2013). The INPADOC family refers to all applications which are a member of the same

[24] The CBS has published a table of how to convert SBI version 1993 to 2008 (CBS, 2012).

[25] The earliest filing date refers to the earliest date of filing of any of the following: (1) the application itself, (2) its international application, (3) its Paris Convention priority applications, (4) the applications with which it is related via technical relations and (5) its application continuations (European Patent Office, 2019a).

extended family. These applications are directly linked to the same root priority application. Usually, the applications are related to the same technical invention, but their individual content may differ (European Patent Office, 2019a; Martinez, 2010).

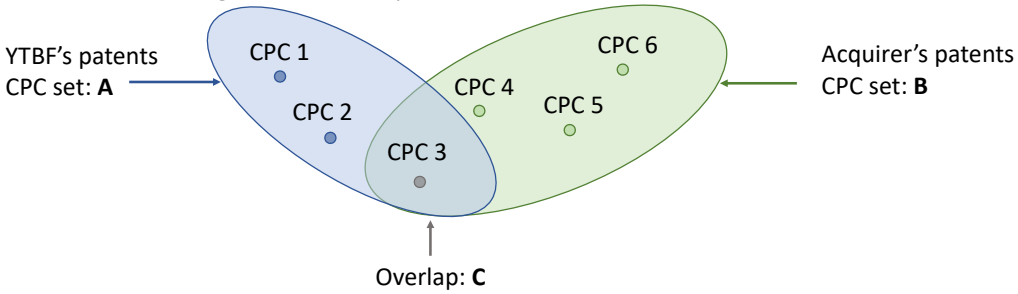
$$Overlap\ of\ sets = A\ \cap\ B = (A + B) - A\ \cup B \quad (1)$$

6.2.3.2 Technology relatedness: CPC and citations

To define the technology relatedness of the YTBF and the acquirer, I developed two proxies. Namely, two distinct proxies that (a) use the CPC classification of patents and (b) use citations. This section elaborates on these.

Technology relatedness: CPC. For all patents and applications of the YTBF the applicable Cooperative Patent Classifications (CPC) were retrieved[26]. This *set* of CPC classifications of the patents of the YTBF (set A) was then matched with the CPC codes of all patents and applications of the acquirer (set B). Through using equation 1, the overlap between CPC classifications could be determined (set C). Figure 6.5 provides a visual overview of this situation. The overlap refers to the overlap in the variety of CPC classifications of the YTBF relative to the acquirer. It does not weigh the occurrence of a specific CPC classification for the YTBF or acquirer but represents the variety of CPC classifications. Important to note, only documents of the YTBFs and acquiring parties applied for before acquisition were considered.

Figure 6.5. Overlap of CPC classifications. Own elaboration.



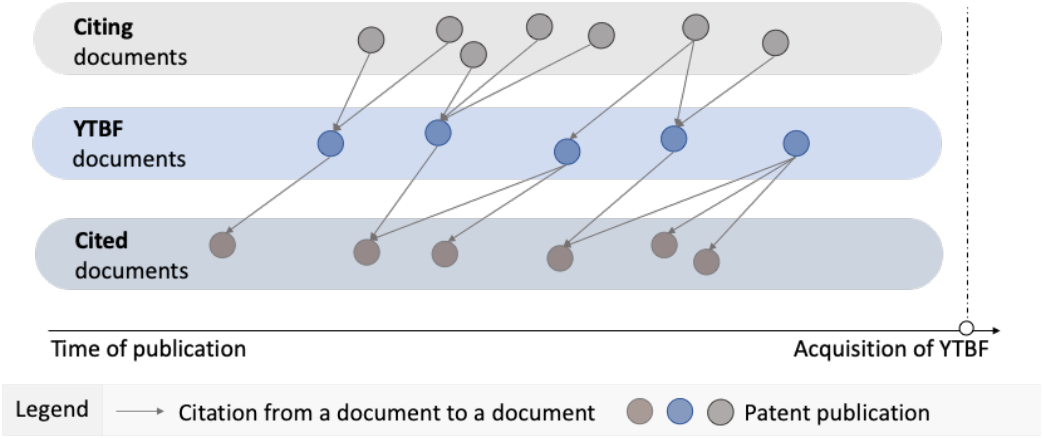
This overlap was determined for two different resolutions of the CPC classification. Namely, the full CPC classification and the main group of a section's class' subclass (8 digits). CPC codes were retrieved using the PAT_PUBL_ID and APPLN_ID and querying CPC information from TLS244.

Technology relatedness: Citations. To complement the CPC overlap, cross-citations were considered as an indicator of pre-acquisition relatedness and firm familiarity. This finds inspiration in the study of Marco and Rausser (2011). Here the focus is on determining any link between the YTBF and acquirer in the pre-acquisition period, by analysing citations between these two parties. For this, all the citing and cited documents of applications of the YTBF applied for before the acquisition were retrieved. Citing documents, or forward citations, refer to those documents that cite the YTBF's documents. Cited documents, or backward citations, are those documents that are cited by the YTBF's documents. Figure 6.6 presents this conceptualisation visually.[27]. From these documents, it was defined which citations were from and to the acquiring party. This then defined if the acquirer cited the YTBF and if the YTBF cited the acquirer.

[26] IPC codes were not considered due to various reasons; (1) CPC codes are based upon the IPC classification, (2) CPC classifies more different classes (3) the CPC classification is used both by the EPO and USPTO and is expected to be used by more authorities in the future (Hjørland, 2017) Additionally, due to research constraints doing both was beyond the scope of the thesis.

[27] These two types of citations were retrieved from PATSTAT using different approaches. For backward citations, this was done by querying the relevant APPLN_ID and all related PAT_PUBlN_ID from TLS212. For forward citations, the APPLN_ID and PAT_PUBLN_ID were set as the CITED_APPLN_ID and the CITED_PAT_PUBLN_ID respectively.

Figure 6.6. Citing and cited documents of YTBF's patents before acquisition. *Own elaboration.*



Therefore, the operationalisation deviates from Marco and Rausser's, as the interest is in verifying if there are cross-linkages. These authors normalise citations with the number of patents, which they use as an explanatory variable within their analysis. Additionally, this deviates from (Ahuja & Katila, 2001) (see Chapter 3). Where these authors focus on the size of the knowledge base and consider qualitative overlap in the prior art, the interest here lays in pre-acquisition citations of patents (applications) of the acquirer to patents (applications) of the YTBF, and vice versa. Given the operationalisation of these authors, these citations are left out - since a document does not cite itself. Consequently, the absolute and relative size of the knowledge base focuses only on citations to the prior art of *others*.

6.3 Post-acquisition firm survival and technology development

Sub-question 3 addresses what happens to the firm and technology after acquisition? Chapter 3 reviewed studies that predicted and found different impacts. Hence, this section introduces the methods used to determine post-acquisition impact on two different levels, (1) the survival of the firm and (2) the development of the technology.

6.3.1 Post-acquisition firm survival

The method to define the impact of the acquisition on the survival of the firm focused on directly available information regarding the post-acquisition integration or operating status of the YTBF. Information was retrieved on post-acquisition activities, subsequent acquisitions (like Sub-section 6.2.2), termination, truncation, independence and integration. This information was retrieved using annual reports of both the YTBF and acquiring party through Company.info and Google Search, and information from news-websites and archived newspapers through the Delpher platform.

6.3.2 Post-acquisition technology development

Besides the survival of the firm, the technology could be affected. Technology development, to a certain extent, can be decoupled from firm survival. For example, the acquirer terminates the YTBF but integrates the technology. Alternatively, the acquirer integrates only human resources but stops YTBF's technology development. Hence, the focus is on indicators of post-acquisition technology development. Two approaches were used, (1) one based on directly available data, (2) the other through the development of two proxies. These proxies differentiate between the use of (2a) CPC classifications and (2b) citations.

6.3.2.1 Post-acquisition technology development: patents and documented activity

In determining post-acquisition technology development, two direct information sources were used. First, for all YTBF, new patent applications were examined to determine continued (in-house) technology development. Second, qualitative data similar to Sub-section 6.3.1 was retrieved to determine

continued activities. This included information from annual reports and media outlets on R&D related firm activities.

6.3.2.2 Post-acquisition technology development: CPC overlap and citations

There might be little direct evidence for technology development, especially for subsumed firms. Hence, to complement the previous section, two proxies were developed, using (a) CPC classifications and (b) citations. Depending on the integration of the YTBF, there are two different scenarios relevant for these proxies: (1) when there is no YTBF patenting activity after the acquisition and (2) when there is continued YTBF patenting activity. Hence, the proxies utilise the patent applications and publications of the YTBF and acquirer before and after the acquisitions, as opposed to Section 6.2. Given this scope, Table 6.3 provides an overview of the indicators of Sections 6.2 and 6.3 regarding the usage of patents applied for before and after the acquisition.

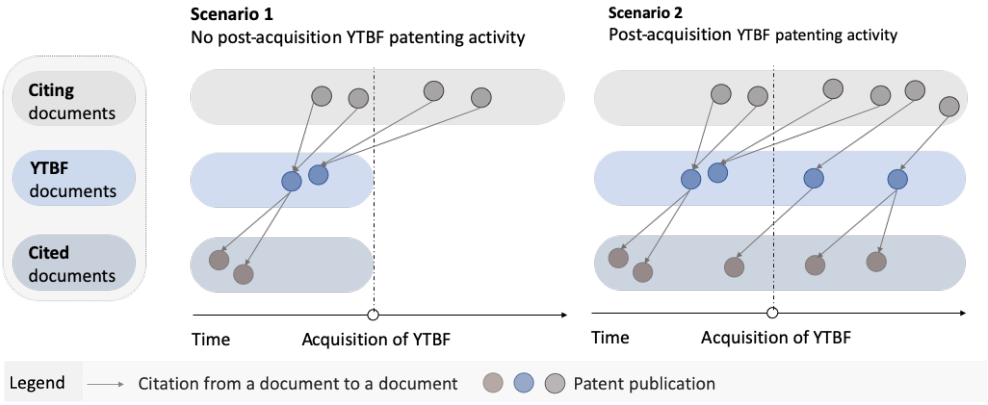
Table 6.3. Usage of pre-and post-acquisition applications and publication by acquirer and YTBF.

Applicant	Before acquisition	After acquisition
YTBF	Technology relatedness and continued technology development	Continued technology development
Acquirer	Technology relatedness	Continued technology development

Post-acquisition technology development: CPC overlap. CPC classifications were used to determine a proxy for continued technology development by the acquirer. The conceptualisation used the overlap between (a) all CPC codes of patents of the YTBF applied before and after the acquisition and (b) the CPC codes of post-acquisition filings of the acquirer. The overlap between these two might indicate continued development in the areas of technology to which the acquired patents pertain. In case of post-acquisition patent applications of the YTBF, the overlap with the post-acquisition filings of the acquirer was determined.

Post-acquisition technology development: citations. Contrasting to Sub-section 6.2.3.1, which considers forward citations before the acquisition, the developed proxy of continued development was based on forward and backwards citations after the acquisition. For introduced scenario 1, in case technology is developed by the acquirer that is inspired by the YTBF's technology, respective patents could receive citations of the acquirer. For scenario 2 this is also applicable, as well as that post-acquisition patent filings of the YTBF could receive citations from the acquirer and possibly cite the acquirer's patents. Following, the proxy focuses on the post-acquisition publications of the acquirer citing pre-acquisition publications of the YTBF (scenario 1 and 2), and post-acquisition publication's citations between these two parties (scenario 2). Figure 6.7 provides a visual overview of this. For both scenarios, the proxy revealed additional information regarding potential technology development which was integrated into or spilled over to the acquiring firm.

Figure 6.7. Citing and cited documents of YTBF's patents after acquisition: two scenarios. Own elaboration.



6.4 Assignment data: usage and validity

A fundamental aspect of the methodology is the usage assignment data. As was discussed in Chapter 4, there are different challenges associated with the use of this data. More specifically, Chapter 4 discussed limitations regarding knowledge about best practices in the context of studying cross-border acquisitions using assignments and limitations regarding the completeness of assignment data. These two aspects were analysed to increase understanding of using this data in the context of acquisitions and put the limitations in perspective.

6.4.1 Assignment data and patent authorities

Currently, there are no studies that have analysed the usage of recorded assignments of different patent authorities from the perspective of acquisitions. Additionally, only a subset of the 96 inscriptions identified in Sub-section 6.1.1 is discussed in the literature. Hence, the usage of these assignments was analysed in order to advance the research fields' understanding. Given the *narrow acquisition perspective* of the YTBF, the occurrence of assignments recorded by different patent authorities and for the different EVENT_CODES was analysed. A similar analysis was carried out for those assignments related to spinning-off. Both analyses provide insights into the use of assignments for future studies.

6.4.2 Assignment data: completeness

Chapter 4 discusses the self-selection bias for assignment data. This bias means that those companies that did not register ownership changes by default are not identifiable. Since there is little research on the incentives to register ownership changes, it is impossible to conclude how much firms are excluded.

However, in the other parts of the methodology, a substantial amount of data was analysed regarding acquisitions of Dutch firms. In case other acquisitions were mentioned in the studied news outlets, annual reports and blogs, these were stored in a separate data file. From this information, it was determined if the acquired firm had applied for patents, and if these had related assignments (as not all the assignment data was studied, as explained under 6.1.4.). This information then allowed to define if cases were left out. It should be mentioned that this did not involve the filtering of acquisitions through databases, as the author had no access to commonly used M&A databases.

Moreover, in the methodology it became apparent there is another critical limitation regarding data completeness. Not all assignments include information on the assignor. Hence, it was assumed that whenever this was the case, the applicant was the assignor. Given the data of 6.4.1, this data is studied to reflect upon how the assumption affected this data. Here the assignments part of the narrow acquisition perspective and spinning-off were analysed. This analysis was performed on the level of assignments related to inscriptions and authorities.

7 Results of analyses

The previous chapters introduced the acquisitions of Dutch YTBFs by foreign firms. Chapters 3-5 reviewed literature regarding the proposed research and sub-questions and informed the defining of the analysis. This materialised in the methodology, as introduced in Chapter 6. This chapter presents the results of the analyses. The results are discussed according to a structure which is consistent with the structure of the methodology:

I. Section 7.1 presents the quantification of the acquisitions and informs sub-question 1.
II. Section 7.2 presents the characteristics of the acquisitions, the involved firms and the involved technology to inform sub-question 2.
III. Section 7.3 presents the results regarding post-acquisition firm survival and technology development to inform sub-question 3.
IV. Section 7.4 presents the results regarding the analysis of the usage and completeness of assignments, this to inform the limitations of using assignment data.

These sections discuss different results. For these different tables are presented, which span multiple pages. To facilitate navigability, I introduce these here.

1. Table 7.1 provides an overview of the characteristics of the identified acquisition of Dutch YTBFs.
2. Table 7.2 describes the YTBF's that were acquired, allowing for familiarisation.
3. Table 7.3 contains information on the characteristics of the YTBF.
4. Table 7.4 offers an overview of the technology relatedness of the YTBF and acquirer.
5. Table 7.5 presents an overview of post-acquisition firm survival and technology development.

7.1 Quantification of acquisitions

The cleaned and harmonised search space contained 213,259 assignments between 16,696 assignor-assignee pairs. This dataset was subject to manual and automatic validation to determine acquisitions. With the automatic validation, 5,075 assignor-assignee pairs were filtered out. Manual validation of cases in subset-1, which comprised 1,337 assignor-assignee pairs with more than ten observations, resulted in the identification of 17 relevant acquisitions[28]. Following the information gathered during this validation, additional non-relevant cases (i.e. a Dutch firm as the acquirer) were filtered out of subset-2. This subset included all pairs with 1-9 observations. The reduction shifted the size of the subset from 10,284 to 6,135 pairs. The validation of the random stratified sample, five pairs for each number of observations, resulted in the identification of 2 acquisitions. In total 63.5% [29] of pairs and 78.8%[30] of observations were validated, which identified a total of 19 acquisitions of Dutch YTBFs by foreign firms.

7.2 Characterization of acquisition, firms and technology

In total, nineteen YTBFs were acquired. To answer sub-question 2 different sections are presented. Sub-section 7.2.1 discusses the deal value, the timing of the acquisition and the operating status of the firm just before the acquisition. Sub-section 7.2.2 addresses the characterisation of the involved parties. Sub-section 7.2.3 presents the results regarding technology relatedness and familiarity of the parties.

The following five pages provide Tables 7.1-7.5. After that, the text continues.

[28] During this manual validation subsequent acquisition and events related to Profibrix and Pangenetics were identified. Although the first acquisition of Profibrix and Pangenetics were not part of this subset, these were identified during this process. Profibrix' subsequent acquisition is discussed later. Pangenetics' acquisition was part of subset 2.

[29] This number is found by subtracting the 45 validated cases from the new size of subset 2 (6135) and calculating the percentage of this with regards to the size of the final search space (16696).

[30] Based on the number of observations before (213259) and after (44978) validation.

Table 7.1. Overview of acquisitions of Dutch YTBFs by foreign firms.

YTBF	Founding date	Status at acquisition	Acquisition date	Acquirer (ultimate owner)[31]	Nationality acquirer	Listed at time of acquisition	Deal value in millions (€) [32]
Mogen International	1985-11-22	Operating	1997-05-18	Zeneca	England	Yes	64.03
Pangenetics	1995-04-25	Operating	1998-03-12	Tanox Pharma	America	No	5.55**
Crucell	2000-10-01	Operating and listed	2011-02-22	Janssen Vaccines (Johnson & Johnson)	Belgium (America)	No (Yes)	1.679.46
Advanced Laser Separation	2000-10-12	Bankrupt	2014-02-14	ASM Pacific Technology	Singapore	Yes	Undisclosed
Prosensa	2002-01-01	Operating	2014-11-24	BioMarin	America	Yes	548.00
Profibrix	2004-01-29	Operating	2013-06-04	The Medicines Company*	America	Yes	183.77
GreenPeak Technologies	2005-03-04	Operating	2016-04-29	Qorvo	America	Yes	90.00**
Liquavista	2005-06-08	Operating	2010-12-16	Samsung	South- Korea	Yes	Undisclosed
Xpand Biotechnology	2005-12-16	Operating	2017-01-23	Kuros	Switzerland	No	20.00**
Polymer Vision	2006-11-16	Bankrupt	2009-08-07	Wistron Corporation	Taiwan	Yes	7.00**
Silicon Hive	2007-03-15	Operating	2011-02-11	Intel	America	Yes	120.40**
Geotate	2008-03-11	Operating	2009-03-30	U-Blox	Switzerland	Yes	5.50
Priv-ID	2008-09-26	Operating	2011-05-24	Genkey	Norway	No	Undisclosed
SyncNow	2008-09-26	Operating	2014-12-09	Kantar Media	England	No	22.53**
Babybloom Healthcare	2009-04-29	Bankrupt	2017-02-27	Nigbo David Medical	China	Yes	0.80**
Euclid Vision Technologies	2010-01-20	Operating	2014-09-05	Qualcomm	America	Yes	Undisclosed
Lanthio Pharma	2010-09-22	Operating	2015-05-07	Morphosys	Germany	Yes	20.00
Sapiens Steering Brain Stimulation	2011-05-09	Operating	2014-08-25	Medtronic	America	Yes	153.73
Medimetrics	2011-06-14	Bankrupt	2017-06-13	Stoco10	Germany	No	0.02***

* Was not identified using the search space but by validation of the subsequent acquisition.

** Value has not been publicly disclosed. It was determined upon close examination of acquisition, bankruptcy or annual reports or a combination and hence relates to the minimal value paid.

*** Like **, however for this case does not include the value of the intellectual property.

[31] The ultimate owner refers to the parent company of the acquiring company.

[32] Reported deal values, values of shares and other monetary numbers in other currencies are normalized to euro's by using the exchange rate of these currencies for the acquisition date. These exchange rates were found using https://www.poundsterlinglive.com/.

Table 7.2. Description of the acquired Dutch YTBFs and their headquarter at time of acquisition.

YTBF	Description of the firm's activities	Headquarter
Advanced Laser Separation International (ALSI)	Development and manufacturing of optical and photographic instruments, so-called laser separation technologies and products and services derivative to this.	Beuningen
Babybloom Healthcare	Development and sale of products in neonatology and paediatrics.	Leiden
Crucell	Development, commercialization and production of vaccines, proteins and antibodies aimed at the prevention and/or treatment of infectious diseases	Leiden
Euclid Vision Technologies	Development, production and licencing of software related to image recognition.	Amsterdam
Geotate	Development and commercialization of GPS geotagging software and services.	Eindhoven
GreenPeak Technologies	Semiconductor company aimed at the development and commercialization of low power wireless communication technology in the Smart Home domain.	Utrecht
Lanthio Pharma	Biopharmaceutical company focused on the discovery and development of therapeutic lanthipeptides.	Groningen
Liquavista	Research and development in the field of electronic display equipment.	Eindhoven
Medimetrics	Developing, manufacturing and selling of innovative medical systems.	Eindhoven
Mogen International	Biotechnology company aimed at developments in plant breeding.	Leiden
Pangenetics	Biopharmaceutical company focused on the development of monoclonal antibodies for the treatment of immune mediated diseases, cancer, and pain.	Heemskerk
Polymer Vision	Rendering of services related to the research, development, manufacturing and sales of products and systems on the basis of rollable and/or foldable display technology	Eindhoven
Priv-ID	Development, production and commercialization of products and systems in the area of biometrics.	Eindhoven
Profibrix	Development and marketing of products for the haemostasis and regenerative medicine markets.	Leiderdorp
Prosensa	Discovery, development and commercialization of RNA-modulating therapeutics for treating genetic disorders.	Leiden
Sapiens Steering Brain Stimulation	Development, manufacturing and commercialization of electronic equipment, products and systems in the field Deep Brain Stimulating therapy.	Eindhoven
Silicon Hive	Development of parallel processing technology for chips in consumer electronics and mobile phones.	Eindhoven
SyncNow	Development, production and commercialization of software in the field of audio-watermarking.	Eindhoven
Xpand Biotechnology	Development, production and commercialization of biomaterials for bone regeneration and repair.	Bilthoven

Table 7.3. Overview of YTBFs: origin, top-sector, size and funding. For firm size: small refers to 1-10fte, medium to 11-100fte and large to more than 100fte.

YTBF	Firm size at time of acquisition°	SBI 2008 YTBF	Top sector°°	Has received subsidy from RVO or RDA33 before acquisition	Type of founding	Originating entity
Mogen International	Unknown	72193	LSH	Yes	Joint venture	MIP (NL) and Molecular Genetics (US)
Pangenetics	Unknown	72193	LSH	Unknown	Independent*	
Crucell	Large	72193/2120	LSH	Yes	Merger	Introgene and U-BiSys34
ALSI	Medium	267002	HTSM	Yes	Spin-off	Royal Philips
Prosensa	Medium	72112	LSH	Yes	Spin-off	Leiden University Medical Centrum
Profibrix	Medium	2120	LSH	Yes	Independent*	-
GreenPeak Technologies	Medium	46695	-	Yes	Independent*	-
Liquavista	Medium	72192	HTSM	Yes	Spin-off	Royal Philips
Xpand Biotechnology	Medium	86929	-	Known EU subsidies	Independent*	-
Polymer Vision	Medium	72192	HTSM	Known EU subsidies	Spin-off	Royal Philips
Silicon Hive	Medium	261109	HTSM	Yes	Spin-off	Royal Philips
Geotate	Medium	6420	-	Unknown	Spin-off	NXP**
Priv-ID	Small	2611	HTSM	Unknown	Spin-off	Royal Philips
SyncNow	Medium	6201	HTSM	Yes	Split-up	Civolution**
Babybloom Healthcare	Small	2660	HTSM	Yes	Independent*	-
Euclid Vision Technologies	Small	6202	-	Yes	Spin-off	University of Amsterdam
Lanthio Pharma	Small	72113	-	Yes	Spin-off	Applied Nano systems***
Sapiens Steering Brain Stimulation	Medium	2660/46462	HTSM	Yes	Spin-off	Royal Philips
Medimetrics	Small	2660	HTSM	Yes	Spin-off	Royal Philips

° Based on reported full time equivalent employees in the year prior to acquisition, in some cases the information used is from two years before.

°° For top sectors: LSH = Life Sciences & Health, HTSM = High Tech Systems & Materials

* No evidence for spinning of or other founding methods were found for these companies and hence it was considered these were independently founded.

** In turn are spun-off/split-off from Royal Philips

*** In turn is a spin-off from the university of Groningen, which is not found in the search-space.

[33] RDA refers to subsidies provided by the Regional Development Agencies, these include for example InnovationQuarter and BOM. Subsidies include innovation credit, salary subsidies for research and development (WSBO) and other loans and grants.

[34] Respectively founded in 1993 and 1996.

Table 7.4. Overview of technology: CPC overlap, citations and transferred families.

YTBF	CPC overlap with acquirer		YTBF citing acquirer	Acquirer citing YTBF	Transferred families INPADOC[35]					
	Full CPC	Main group			A: Origin - YTBF	Overlap A and B	B: YTBF - Acquirer	Overlap B and C	C: Origin - acquirer	Overlap A and C
Mogen International	55.24%	69.23%	Yes	Yes	0	0	24	-	-	0
Pangenetics	82.35%	100.0%	No	No	-	-	4	-	-	-
Crucell	34.71%	78.87%	No	Yes	3236	0	43	0	0	0
Advanced Laser Separation	56.00%	85.71%	No	Yes	0	0	5	0	0	0
Prosensa	66.23%	91.67%	Yes	Yes	1	1	13	2	2	1
Profibrix	44.44%	23.08%	Yes	No	-	-	0	-	-	-
GreenPeak Technologies	16.87%	40.00%	No	No	-	-	8	-	-	-
Liquavista	88.61%	95.83%	Yes	Yes	8	4	21	3	50	7
Xpand Biotechnology	30.77%	47.62%	No	Yes	-	-	1	-	-	-
Polymer Vision	79.67%	74.19%	Yes	Yes	29	24	101	37	42	29
Silicon Hive	95.76%	100.0%	Yes	Yes	30	28	36	25	28	26
Geotate	84.38%	75.00%	No	Yes	8	8	11	2	2	2
Priv-ID	59.26%	33.33%	No	Yes	3	3	8	1	1	1
SyncNow*	0.00%	0.00%	No	No	4	2	4	2	2	2
Babybloom Healthcare	57.14%	100.00%	No	No	-	-	2	-	-	-
Euclid Vision Technologies	91.30%	80.00%	No	No	1	1	2	0	0	0
Lanthio Pharma	30.77%	57.89%	No	Yes	3	2	4	2	2	2
Sapiens Steering Brain Stimulation	98.28%	100.00%	Yes	Yes	28	24	40	7	8	7
Medimetrics	11.96%	33.33%	No	Yes	24	24	25	17	18	18

* Because SyncNow was split-off from Civolution specifically for the sale to Kantar, this information refers to Civolution

[35] DOCDB families were analysed as well, however, the number of DOCDB families only differed in the range of 1-2 for a limited number of cases. Therefore, these are not reported.

[36] Of which 31 originate from Introgene.

Table 7.5. Overview of post-acquisition status of the YTBFs.

YTBF	New YTBF INPADOC AA *	AA acquirer citing BA YTBF INPADOC	AA acquirer citing AA YTBF INPADOC	Subsequent acquirer	Difference with first acquisition	Firm integration	Current operating status of YTBF, integrated department or product offering
Mogen International	10	1	0	-		Integrated	Closure
Pangenetics	7	1	0	-		Integrated	Sold various patents to Abbott in 2009
Crucell	39	22	22	-		Integrated	Operating
Advanced Laser Separation	0	2	-	-		Integrated	Growing
Prosensa	0	2	-	-		Integrated	Unknown
Profibrix	0	0	-	Mallinckrodt	2,7 years	Integrated	Unknown
GreenPeak Technologies	3	0	0	-		Integrated	Truncation
Liquavista	39	15	9	Amazon	2,4 years	Independent	Closure
Xpand Biotechnology	0	0	-	-		Integrated	Growing
Polymer Vision	39	27	6	Samsung**	5,9 years	Independent	Closure
Silicon Hive	0	5	-	-		Integrated	Truncation
Geotate	0	7	-	-		Integrated	Products are sold
Priv-ID	0	0	-	-		Integrated	Products are sold
SyncNow*	0	0	-	-		Integrated	Products are sold
Babybloom Healthcare	0	0	-	-		Integrated	Products are sold
Euclid Vision Technologies	0	0	-	-		Integrated	Unknown
Lanthio Pharma	0	0	-	-		Independent	Operating
Sapiens Steering Brain Stimulation	0	7	-	-		Integrated	Closure
Medimetrics	0	0	-	Progenity	2,3 years	Recently acquired (18-09-2019)	

* AA refers to applications after acquisition, BA refers to applications before acquisition. For this the EARLIEST_FILING_DATE was used.

** It only considers the intellectual property rights. The firm was ceased before.

7.2.1 Characteristics of acquisition: deal value, operating status and timing

This section addresses the characterisation of the acquisition, divided over different sub-sections. The results include the acquisition speed, deal value and operating status of the YTBFs before the acquisition.

7.2.1.1 Acquisition: Speed

The average (mean) time between founding and first acquisition is 6.9 years ($N = 19, SD = 3.9$). This average is close to the earlier reported 6.4 by the study of (Bruno & Cooper, 1982). To compare this result to the study of (Pisoni & Onetti, 2018) the acquisition age was differentiated between three groups of acquisition age: 0-5 (42.1%), 6-10 (32.6%) and 11-15 (26.3%). Although a different scope and smaller sample, their study reports a similar distribution (36%, 29% and 25% respectively[37]).

7.2.1.2 Acquisition: Deal value

Unfortunately, data about the deal value of acquisitions was not always available. In some cases, the deal value was recovered through extensive research of annual, acquisition and bankruptcy reports. For example, no media outlet reported the deal value for Silicon Hive. For multiple cases, a close examination of annual reports through Companyinfo.net allowed calculating the minimal value paid based on reported payments. However, making further inferences is difficult, given different intensities in what is acquired. For example, before the acquisition of Lanthio Pharma, MorphoSys already held 19.98% of Lanthio Pharma (based on examination of annual reports). Therefore, the documented €20 million only refers to the other outstanding shares. So, various *minimal* deal values were defined and characterise the specific valuation of the acquisition. The data shows that most acquisitions involve a substantial valuation of the YTBF, in the tens and even hundreds of millions.

7.2.1.3 Acquisition: Operating status of Young Technology-Based Firm before acquisition

Taking into account the operating status of the YTBF at the time of the acquisition shows that 4 YTBFs were bankrupt at the time of acquisition (Table 7.1). However, patents were transferred as part of an acquisition of the firm or assets afterwards (Table 7.4, the *column on transferred patent families between the YTBF and the acquirer*). Accordingly, this is in direct line with the findings of (Serrano & Ziedonis, 2018) regarding the redeployment of patent assets.

7.2.2 Characteristics of involved parties

This section addresses the characterisation of the involved parties. Here characteristics of the YTBF and acquirer are presented. For the YTBF this includes characterisations according to (1) the origin of the firm (2) the receiving of subsidies, (3) its location, (4) its membership to a top sector and (5) its size. For the acquirer, this includes the (6) nationality and (7) economic power.

7.2.2.1 Young Technology-Based Firm: Origination of the firm

From Table 7.3, it becomes apparent that from the nineteen firms, twelve have spun or split-off from another entity, one is founded due to a merger of two Dutch YTBF[38], one is founded as a joint venture, and five are (as far as information shows) independently founded. From these twelve spin-offs, a total of eight YTBFs have directly or indirectly (SyncNow) spun-off from Royal Philips (42.1%).

7.2.2.2 Young Technology-Based Firm: Received subsidies

Another aspect of the YTBF regards the receiving of subsidies. From fourteen YTBFs, it was identified that these received funding or loans by either the RVO (or its predecessors) or the Regional Development Agencies (RDA). Additionally, from the remaining YTBFs, it was identified that two received funding or loans from the European Union. For the remaining three companies it can be assumed that these YTBF

[37] These authors also included the 16-21 age category (10%).

[38] This refers to the merger between Introgene and U-BiSys. Given the founding years of these firms, Crucell is identified as a YTBF in line with the operationalisation put forward in Section 1.2.

could have benefitted from WSBO[39] as it is likely that these have spent money on R&D personnel. WBSO is a Dutch R&D tax credit on R&D spending.

The founding of Mogen International is discussed for purposes of clarity regarding received subsidies as it represents a remarkable situation. Following old newspapers in Delpher, it is found that in the early 1980s a commission was tasked to research and develop potential new areas for economic development in the Netherlands. The idea: invest in joint ventures that are established as Dutch companies and through this attract and keep new knowledge in the Netherlands. One of the results: the founding of Mogen in 1985 as a Dutch subsidiary of the Dutch American Molecular Genetics through the involvement of the investment fund MIP (*Maatschappij voor Industriële Projecten*). MIP participated in 49,9% of the shares and invested 2 million US dollars. Another 2 million was provided by the ministry of economic affairs, the Province Zuid-Holland and the municipality of Leiden. After two years, Mogen became independent (hence meeting the operationalisation of a YTBF as put forward in Section 1.2).

7.2.2.3 Young Technology-Based Firm: Location

Table 7.2 contains, in brief, an overview of the YTBF's self-reported main activity and the legal seat of the YTBF, as the last known location before the acquisition. This information shows that five YTBFs were located in the Leiden region, and 8 in the Eindhoven region. For Eindhoven, this could closely be related to the fact that most of the YTBFs origination was related to Philips. Importantly, the location of the legal seat does not necessarily define the location of the YTBF's R&D activities.

7.2.2.4 Young Technology-Based Firm: Relation to industry and Dutch Top Sectors

The SBI codes of the YTBF (Table 7.3) reveal overlap in categorised activities. Translating SBI 2008 to 1993 puts the found acquisitions in perspective relative to the overall number of patent applicants in these sectors, using the study of (de Heij & Kuipers, 2010). In the period 2000-2006, a total of 511 entities with the same SBI classifications as the one of the YTBFs[40] applied for patents at the Dutch patent authority, and 453 at the EPO. As the authors (2010) did not include an analysis regarding the overlap of applicants at these two authorities, this is unknown. Future longitudinal studies on Dutch patent applicants could reveal a more up to date overview.

Moreover, the SBI was used to generalise the YTBF's activities on the level of the Dutch Top Sectors. The Dutch Top Sector distinguishes between 9 Top Sectors[41]. However, for 15 of the YTBF in Table 7.3, only two are represented: (1) Life Sciences & Health and (2) High-Tech Systems & Materials. The other four firms are, based on the methodology in (CBS, 2018), not part of a top sector. However, based on the explanations of activities (Table 7.2.), it could be argued that GreenPeak is related to High-Tech Systems & Materials. Complementary, Xpand Biotechnology and Lanthio Pharma relate to Life Sciences & Health. This highlights a shortcoming of the SBI to Top Sector conversion, which only considers the classification of a firm to a specific SBI.

These findings can be compared to the study by Snoei, Seip and Van der Linden (2013)[42], who studied patent applications and applicants in the Dutch Top Sectors over the period 2006-2010. In this period, 25,464 patents were applied for by 2,126 different firms that are part of the Top Sectors. Here two interesting observations are made. First, the firms that are part of the Top Sector High-Tech Systems & Materials in total account for the highest number of patent applications in this period. Moreover, almost two-thirds of the 2,126 firms are part of this Top Sector. The predominance of this Top Sector

[39] WSBO is the Wet Bevordering Speur- en Ontwikkelingswerk, an initiative that allows firms to pay less wage tax if they develop undertake technical or scientific research, develop technical products, develop physical production processes or develop the related software. Before the WBSO, there were different initiatives with similar benefits.
[40] For this the classification of GreenPeak Technologies is not considered as this SBI code includes car-related companies, and GreenPeak technology activities are not within this business area.
[41] These are (1) Agri-food, (2) Chemicals, (3) Creative Industries, (4) Energy, (5) High Tech Systems & Materials (HTSM), (6) Life Sciences & Health (LSH), (7) Logistics, (8) Horticulture & Propagation Materials and (9) Water.
[42] This study uses the methodology as provided by the CBS. Other research by Agentschap NL (a predecessor of RVO) has used IPC classifications as a method to categorise firms into Top Sectors.

also comes back in this data, regarding acquisitions. However, for the Top Sector of Life Sciences & Health, the observation is different. This Top Sector only accounts for slightly more than 6% of the 2,126 firms, whereas the Top Sectors of Agri-food, Chemicals, Energy and Water, represent a larger number of firms. Any of the found YTBFs does not represent these Top Sectors.

For both comparisons, current studies and published datasets do not allow for the breaking down of data according to the age of firms. Hence no inferences can be made regarding the number of young firms that have applied for patents in The Netherlands. Following the definition put forward in Section 1.2, this does not allow for the definition of the number of YTBFs, and their distribution according to SBI and Top Sector. Hence, additional research is needed to define if firms in these Top Sectors are acquired by foreign firms, if patents are assigned (maybe these come back in the remainder of the data) and how this relates to the studied acquisitions.

7.2.2.5 Young Technology-Based Firm: Firm size

Table 7.3 contains information on the size of the YTBF before the acquisition. The data shows that only Crucell can be considered as a large firm at the time of the acquisition, which had more than 1000 employees at that time. This observation might be related to the fact that Crucell was a merger of firms (Introgene and U-BiSys) and that it has acquired various other companies in the years prior to the acquisition (i.e. Berna Biotech from Switzerland and SBL Vaccin from Sweden). Table 7.3 highlights the presence of eleven medium YTBFs and five small YTBFs. The size of two companies was unable to be identified, based on limited historical data and the impossibility to retrieve a credible account of the number of employees (Mogen International and Pangenetics). In general, the acquired YTBF are in the range of 1-100 FTE employees.

7.2.2.6 Acquirer: Nationality

This study is the first analysing Dutch YTBF acquisitions by foreign firms. In this ambition, the identification of the nationality of the acquirers characterises these events. Both acquirers from America and the European region represent eight out of nineteen acquisition. The remaining three acquisition involve acquirers from Asia. Interestingly, American firms were involved in the six highest defined grossing deals of Dutch YTBF. Moreover, Asian acquirers were only involved with firms that were bankrupt at the time of acquisition.

7.2.2.7 Acquirer: Economic power and firm size

In addition to the nationality of the acquirer, the size was defined. Table 7.1 reveals that fourteen acquirers are listed on a stock exchange at the time of the acquisition. All fourteen are large firms in terms of FTE. This large size and listing might indicate potential buyer and economic power. From the unlisted firms, Kantar Media is a large firm, Genkey and Kuros are small firms, and the size of Tanox Pharma and Stoco10 could not be determined. Consequently, in fifteen of the cases (except for Stoco10, Genkey, Kuros and Tanox) it could be defined that the acquirer or ultimate owner was larger in FTE than the YTBF. This tendency of acquiring smaller firms by larger incumbents is in line with previous research (e.g. Andersson & Xiao, 2016; Panagopoulos & Park, 2008).

7.2.3 Characteristics of technology

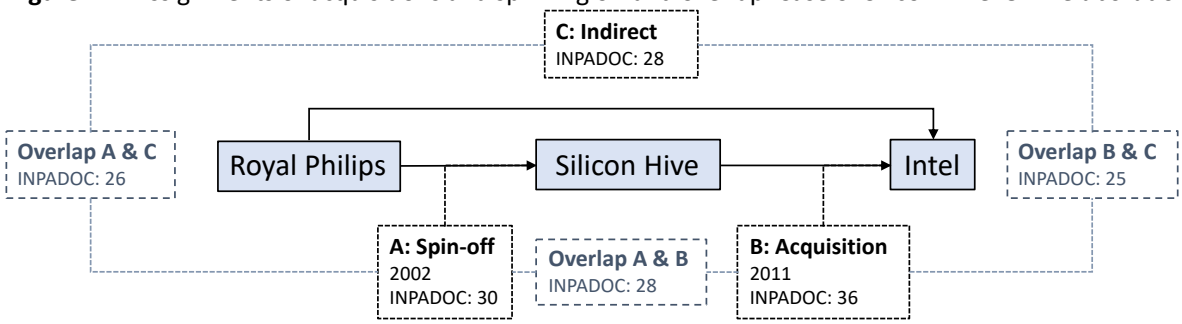
In this section, the technology is characterised to continue to inform sub-question 2. Three aspects are considered, namely (1) the origin of the transferred patents (2) the overlap in CPC classifications and (3) pre-acquisition cross-citations between the YTBF and the acquirer.

7.2.3.1 Technology origin

Table 7.4 provides information on assignment between three different actors. Namely, the YTBF, the acquirer and a potential originating firm. This data is presented on the level of INPADOC families assigned. From the YTBF that have an originating firm ($N = 14$, Table 7.3) Table 7.4 shows the presence of assignments from this originating firm to the YTBF. Only for Mogen and Advanced Laser Separation

International (ALSI), this origination is not identifiable through assignment data. Table 7.4 also includes the number of families assigned during acquisition (from YTBF to acquirer) and the number of patent families that have been assigned *indirectly* (from origin to acquirer). Among these *flows*, the overlap was calculated using equation 1. Given Table 7.4, one can distil information for a visual overview of applicable two events relevant to the YTBF acquisition and technology origin. Figure 7.1 provides an example of Silicon Hive.

Figure 7.1. Assignments of acquisitions and spinning off and overlap. Case of Silicon Hive. *Own elaboration.*



From this overview, it is inferred that of the 36 INPADOC families assigned to Intel by Silicon Hive, patents of 28 families were assigned from Royal Philips to Silicon Hive. The focus on patent families allows generalising on the level of technology rather than patens. This means overlap could include patents which would not overlap when the focus is on the overlap of patents, as families can span multiple patents. This data shows that the basis of the technologies part of the families assigned from Silicon Hive to Intel, in most cases was also part of the spinning-off. Moreover, the example shows overlap with the indirectly assigned patent families, which is discussed in more detail in Section 7.4. In general, considering the ratio of overlap between *overlap* $A\&B$ relative to B, for those companies were flow A contains assignment data, the average overlap amounted to 45.38% $(N = 12)$. Hence, a substantial part of the assigned patent families for the acquisition was also assigned by the originating firm to the YTBF.

When taking a closer look at the specific cases, there are substantial differences. Taking the extreme difference in relative overlap, this amounts Crucell (0%) and Medimetrics (96%). Hence, for Medimetrics, most of the assigned families also were present in Royal Philips. In the case of Crucell, this implies no incentive or need for Johnson & Johnson to assign Crucell's patents that originated in either Introgene or U-BiSys. This might be related to possible independence of Crucell after the acquisition, the age of these patents and a potential pivot of Crucell to different technology after the merger that founded Crucell. A larger sample with similar cases is needed to analyse potential explanations.

It is important to mention that the indirect assignments could relate to different transactions. For example, it could be part of *related* deals. In the case of the acquisition of Geotate, there was a deal to acquire additional patents from NXP (U-Blox, 2009). Moreover, it could be just easier to assign a patent from the originating firm to the acquiring firm in case of no assignment of a patent to the YTBF.

7.2.3.2 CPC overlap

A second characteristic is an overlap between the CPC classifications of patents of the YTBF and the acquirer. For this, all patents that were assigned by a potential origin to the YTBF, as well as YTBF's own patent applications, were considered. Table 7.4 shows the overlap between the variety of CPC classifications of the YTBF and acquirer, based on both firm's applications and patents with the earliest filing date before the acquisition. The overlap is presented as a percentage relative to the CPC space of the YTBF. This characteristic did not consider the weighting of CPC classifications. Two different resolutions are presented, namely CPC-full and CPC-eight (the level of the main group of a section's class' subclass).

The overlap on the level of CPC-full variety shows that for all cases, except SyncNow, the acquirer has applications with overlapping CPC classifications. The average overlap is 60.59% (including SyncNow)

of all CPC classifications of the YTBFs. On the CPC-eight level, the average overlap is 72.42%. Interestingly, when looking at the cases, multiple acquisitions are characterised by a 90-100% overlap on the CPC-full or CPC-eight level. For example, the acquisitions of Sapiens Steering Brain Stimulation and Silicon Hive represent a 100% overlap on the CPC-eight level and a >90% overlap for CPC-full.

Additionally, one can consider the differences between the overlap of variety on the two different levels. Based on the resolution of CPC-full and CPC-eight and in case an acquisition has a higher overlap on the level of CPC-eight, this might indicate that the YTBF's wider technology area overlaps with the acquirer. This, in turn, indicates specific CPC-full classifications not found within the acquirer's patent domain, but which are related or complementary. On the other hand, when the main group's overlap is lower, this might indicate a more specific area in which the variety of the two knowledge bases overlap. This since there is a higher overlap in variety on a higher level of CPC classifications.

7.2.3.3 Cross-citations

Citations are used to identify pre-acquisition firm familiarity and technology-relatedness (Table 7.4). The YTBF cited the acquirer in 36.8% of the cases, whereas the acquirer cited the YTBF in 63.2% of the cases. The latter one indicates the familiarity of the acquirer with the technology of the YTBF. For all cases except Profibrix, when the YTBF cited the acquirer, the acquirer cited the YTBF. Additionally, none of the small firms cited the acquirer. As citations originate in different stages of the patenting process and related to different origins, no further inferences are made.

When combining citations with CPC overlap, the data shows that for most acquisitions, there is an overlap of more than 50% on CPC-full or CPC-eight and familiarity of the acquirer regarding the YTBF (citations). For these acquisitions, this indicates an overlap in terms of patented technology. The acquisitions of GreenPeak Technologies and SyncNow are characterised by no cross-citations and a low CPC overlap (< 50% on CPC-full and CPC-eight) and indicates the opposite.

7.3 Post-acquisition firm survival and technology development

In this section, the results regarding the post-acquisition firm survival and continued technology characteristics are presented. This informs sub-question 3. *In this section, the source of information is only indicated in cases external information is not from annual reports from Company.info.*

7.3.1 Firm survival: subsequent acquisitions, integration, closure and truncation

This section discusses the post-acquisition operations of the YTBFs. Table 7.5 presents relevant data. From the acquired YTBFs, four (21.1%) have been re-sold to another firm. The average time for this re-acquisition is 3.3 years ($N = 4, SD = 1.7$). Interestingly, in line with the previous discussion on the nationality of the acquirer, half of the acquirers are American. Furthermore, four YTBFs (21,2%) were closed a few years after the acquisition. The most striking example here is Mogen International, which was founded by the Dutch MIP. Shortly after 1997 Zeneca merged with Astra, after which AstraZeneca's agriculture-department (including Mogen) merged with a similar department of Novartis. This merger formed Syngenta. Within Zeneca, Mogen was still operating. However, in the new formed Syngenta its Dutch activities were terminated (van ’t Hoog, 2002). In this case, the ambition of the government in 1985 to *keep* the *founded* companies proved impossible.

Taking into account the origins of the YTBFs, four out of the eight companies originating in Philips were truncated or closed after the acquisition or subsequent acquisition. These represent the main share of terminated and truncated companies (four out of six). Interestingly, these four companies had a high CPC-full and CPC-eight overlap and cross-citations with the acquirer.

Multiple firms present a different post-acquisition trend. For ALSI, specific activities have grown after the acquisition. Before the acquisition, ALSI sold its developed machines independently. Now the network of ASM PT is used, resulting in increased turnover. The usage of this network had various advantages, including the trust of the buyers (LINK, 2019). Another case is Lantio Pharma, where the acquirer (Morphosys) owned shares before the acquisition. Annual reports highlight that some patents were transferred to MorphoSys before the acquisition. At the same time, Lanthio Pharma kept the rights

to these technologies and received payments depending on these patent-related results obtained by MorphoSys. MorphoSys' annual reports show that Lanthio was acquired since Morphosys saw it as complementary to their product-portfolio.

Moreover, some YTBFs were integrated of which their product or technology is currently sold or integrated into new products. For example, the technology of SyncNow is offered (at the time of writing) as a service by Kantar Media. Additionally, Babybloom's products are integrated into the product portfolio of the acquirer. The bankruptcy report of Babybloom Healthcare indicated that it was acquired specifically for the technology.

This section reflects the ambiguity highlighted in Chapter 3 regarding the predictions and empirical findings of cross-border acquisitions. In line with previous research, the differences between the cases highlight that the economic effects of these acquisitions seem to depend on the characteristics and circumstances of the transaction (Ahuja & Katila, 2001; Carpentier & Suret, 2014; Mason & Harrison, 2006). Although this analysis informs upon revealed choices of the acquirers, additional cases and information are needed to infer relationships between the firm characteristics, the intentions of the acquirer, the circumstances of these acquisitions and the relationship to firm survival.

7.3.2 Post-acquisition technology development

This section presents the discussion on the continued technology development regarding documented activity, citations and CPC overlap.

7.3.2.1 Continued technology development: CPC overlap

Here the overlap between the CPC classifications of filings of the YTBF before (and after) the acquisition and the filings of the acquirer after acquisition are considered. This overlap allows calculating the difference with the pre-acquisition overlap, as shown in Table 7.4 and discussed in Section 7.2.3.2. Appendix F provides this difference in Table F.1 in terms of the absolute difference in percentages. The data shows that in all cases, the overlap of CPC-full decreases (-24.57% on average). On the level of CPC-eight overlap, this data shows a similar trend (average -18.98%), with one exception, Polymer Vision. This exception might indicate that the post-acquisition overlap in variety is directed towards the pre-acquisition variety of Polymer Vision. In general, there might be multiple explanations of why the overlap has decreased. Explanations include the not filing of new patents in these areas due to a preference for trade secrets, and the inclusion of old patents in the analysis that do not represent the current activities of the YTBF or acquirer. The analysis of the post-acquisition technology development of Xpand Biotechnology, Priv-ID and Medimetrics show a decrease in the overlap of CPC-eight to 0%. The observation indicates that the acquirer has not filed any patents that were classified using the same classifications. Interestingly, for four out of the five firms that have a post-acquisition overlap of >50% on CPC-full and CPC-eight, these have been truncated or terminated (Silicon Hive, Sapiens, Polymer Vision and Liquavista).

7.3.2.3 Continued technology development: Citations

Information in Table 7.4 shows six YTBFs applying for patents after the acquisition, in different intensities. Of five of these six, it is known that post-acquisition R&D continued. So, this finding is in line with post-acquisition continued technology development. The case of Pangenetics here was the unknown, as there was little to no external information available on the case. In ten cases the acquirers have filed for new patents that have cited pre-acquisition patents of the YTBF. In three cases the acquirers' new filings have cited new filings of the acquired YTBF. Here, two of these YTBFs have been acquired by a different firm afterwards.

7.3.2.3 Continued technology development: documented activity

This section discusses three which show the need for additional data and context regarding technology development. First, BioMarin took a gamble when it bought Prosensa for its experimental Duchenne muscular dystrophy treatment in 2014. Drisapersen had already failed a Phase 3 trial, but BioMarin

thought it could still win FDA approval in the US. However, the FDA did not approve. Similar projections for European approval have made Biomarin decide to shelve the research (Fidler, 2016). Second, Medtronic stopped Sapiens' R&D in the Netherlands in 2017, while continuing some parts of the research in the United States. It said to be primarily focused on a competing technology, expected to lead to results faster (Verrijt, 2017). Additionally, although nowhere any information is found on a relation between Progenity and Medimetrics before the acquisition, assignments show the transfer of intellectual property before the acquisition. Given this recent acquisition, it needs to be seen what will happen in the context of the citation and CPC related indicators. These cases highlight the importance of corroborating evidence and further research on understanding the aspects of the acquisitions.

7.4 Institutional framework

The acquisitions discussed in the previous sections were identified using assignment data. As outlined in the previous chapters, there are some uncertainties regarding this data. This section presents the results regarding the analysis of two of these; (1) assignments and patent authorities and (2) data completeness.

7.4.1 Assignment data: patent authorities

As the assignments considered for this study originate in 96 different inscriptions and 29 different authorities, the characteristics of these are analysed. Appendix C includes an overview of how many assignments were related to the acquisitions, from the narrow acquisition perspective, for the different authorities. Appendix G, Table G.1 presents the specific assignments of each acquisition from the narrow perspective, differentiated per inscription and authority. Table G.2 provides similar information for assignments related to the founding of the YTBF through, for example, spinning-off. When looking at these tables, it becomes clear that most assignments studied are from the recordings of the USPTO. This tendency might be related to the number of American acquirers. However, from the 31 interactions included in these two tables, only one does not include an assignment from USPTO data. Interestingly most of the studied assignments paired with European event codes, are in line with previous studies on patent transfers (see Ciaramella et al., 2017).

7.4.2 Assignment data: completeness

Regarding the completeness of the data, two aspects are considered. These concern the possible self-selection bias and the completeness of the data recorded in assignments.

First, given the identified 96 inscriptions and selection criteria of Section 6.1.2, assignments from 32 of these EVENTS_CODES contained no information on the assignee. Moreover, only 23 had no missing information in the PARTY_NEW variable (i.e. USPTO assignments). Also, the assumption made under Section 6.1.3.2 was relevant for a substantial number of these assignments, regarding missing information on the assignor. For the relevant assignments, Tables G.1 and G.2 indicate this. Coupled with the previous discussion on the usage of USPTO's assignments, the data suggest that the use of these assignments currently seem most worthwhile.

Second, as was outlined in Section 6.4.2, additional acquisitions were identified through the consulted media outlets and databases for the manual validations of subset-1 and subset-2. This additional data identified an additional eighteen acquisitions of Dutch YTBFs by foreign firms. Two of these are the other firms that originate in the split-up of Civolution. For none of these acquisitions, assignments are identifiable in the search space. For four of these, this is explained by the fact that the acquisition took place recently. Hence, these acquisitions fall outside the scope of the data currently part of PATSTAT (acquisitions happened in 2018-2019). For the remainder (and in case the just-mentioned cases are not identifiable in the future) this means that there was either no incentive or legal need to document an ownership change. Appendix H includes a list of these YTBFs, as well as information on the founding year, the acquisition year and acquiring party. Importantly, the identification of these acquisitions was a by-product of the validation and merely serves for understanding the limitations of the bias and the use of assignment data.

8 Conclusions and discussions

This thesis focuses on the identification of Dutch YTBF acquisitions by foreign firms through the use of data on patent ownership changes. For this, various indicators were developed and utilised to characterise these acquisitions, the involved firms and the post-acquisition performance of the firm. This final chapter presents the conclusions with regards to the research question in Section 8.1. Furthermore, it offers a discussion on theoretical and methodological contributions in Section 8.2, reflects upon limitations of the research in Section 8.3, proposes recommendations for future research in Section 8.4 and discusses policy implications in Section 8.5.

8.1 Answers research question

The research question guiding this thesis is how often are Dutch YTBF with patents acquired by foreign firms, what characterises these events, and what happens with the YTBF thereafter? Here, a subdivision is made according to three lines of inquiry and ambitions: (1) quantifying the number of acquisitions of Dutch YTBF by foreign firms through assignment data, (2) characterising the acquisition, the involved parties and the technology in terms of relatedness and origin, and (3) characterising post-acquisition firm continuation and activities. For each of these the following sub-sections elaborate on conclusions, followed by a reflection.

8.1.1 Quantification of identified acquisitions through assignment data

To identify acquisitions through assignment data, 96 relevant inscriptions from 29 different authorities were used to obtain relevant assignments. This data was cleaned, categorised and harmonised before it was subject to automatic and manual validation stages. This process resulted in the identification of eighteen acquisitions and four subsequent acquisitions. One of these subsequent acquisitions involved a firm of which a prior acquisition was not identifiable through assignment data. However, it was decided to include this in the analysis as the subsequent *acquisition* was identifiable. Consequently, nineteen acquisitions of Dutch YTBF by foreign firms were identified. For this, almost 170.000 assignments were studied, separated by approximately 10.500 different assignor-assignee pairs.

However, due to research constraints, approximately 45.000 assignments of 6100 pairs of subset-2 were not subject to validation. As the validation of the sample of cases in subset-2 resulted in identifications of acquisitions, I expect that different acquisitions are identifiable in this data. Making inferences about the number of acquisitions overlooked is complicated, due to uncertainties around the incentives for registration and the self-selection bias. For this, the identification of other such acquisitions, as a by-product of the validation phase, provides some perspective. As was introduced in Section 7.4.2, eighteen other acquisitions of Dutch YTBFs by foreign firms were identified in this process. None of these acquisitions involves assignments. This finding indicates that a crucial aspect of assignment data is that not all YTBF acquisitions are identifiable. The sections on limitations and recommendations for future studies addresses this in more detail.

8.1.2 Characteristics of acquisitions, firms and technology

Acquisitions identified through the assignment data were characterised according to multiple aspects. Regarding the acquisitions, the average (mean) time between founding and first acquisition is 6.9 years. This acquisition speed opens up a discussion on the ability of the ecosystem to create independent high-growing firms. Moreover, four YTBFs were bankrupt, at the time of acquisition. The deal values reveal that most of these acquisitions involved a considerable valuation of the YTBF.

In terms of the characteristics of the YTBFs, twelve have spun or split-off from another entity. Eight of these relate to Royal Philips. It is found that at least fourteen YTBFs have benefitted from subsidies and loans provided by either the RVO or RDA's. Interestingly, the YTBFs are part of two Dutch Top Sectors only; Life Sciences & Health and High-Tech Systems & Materials. For the latter one, this could be related to the dominance of Dutch patent applicants in this sector. Moreover, this finding might

indicate foreign interest in YTBFs part of these two top sectors, or hurdles of companies in these top sectors for independent growth. Additional research specifically to this finding is advised.

When taking into account the acquirer, the data shows that both America and the European region account for eight out of nineteen acquisition (so, in total sixteen). Interestingly, the remaining three represent Asian acquirers, which were only involved with bankrupt YTBFs. Additionally, in fifteen cases, it is found that the acquirer was larger than the YTBF in terms of FTE.

In terms of technology, it is found that for all cases except one, the acquirer has patents or applications with overlapping CPC classifications as compared to the YTBF. The average overlap of CPC variety is 60.59% on the full CPC's resolution. Additionally, in 36.8% of cases, the YTBF cited the acquirer before acquisitions, whereas the acquirer cited the YTBF in 63.2% of the acquisitions. By combining information from these two indicators, it is argued that in most cases, the acquirers were related to or familiar with the technology of the YTBF. Lastly, for twelve YTBFs assignments show an overlap between the technologies assigned from the originating firm to the YTBF, and technologies assigned from the YTBF to the acquirer. The average overlap is to 45.38% on the level of INPADOC families. This data indicates that substantial origins of the technology lay in the originating firm.

8.1.3 Post-acquisition characteristics

Regarding the third sub-question, the post-acquisition activities of the YTBFs and acquirers were analysed. Four YTBFs were re-sold to another firm. Additionally, four YTBFs were terminated, which includes two firms that were re-sold. Two YTBFs became truncated firms (only have R&D presence in the Netherlands). Other firms were integrated, representing different intensities in continuation. When considering the post-acquisition CPC overlap and citations, the following results are found. Overlap in variety of the full CPC resolution decreases after the acquisition in all cases. This trend might be related to the inclusion of irrelevant patents, which did not represent the activities of the YTBF at the time of the acquisition. However, these patents do indicate the (historical) knowledge base of the YTBF. For citations, the analysis shows six YTBFs filings, in different intensities, for patents after the acquisition. Of five of these six, it is known that post-acquisition R&D continued. In ten cases the acquirers have filed new patents after the acquisition, which have cited patents of the YTBFs applied for before acquisition. In three cases the acquirers' new filings have cited new filings of the acquired YTBF. Interestingly, from the eight firms originating in Royal Philips, four have been truncated or terminated. This overview shows the varied landscape of post-acquisition characteristics and amplifies the ambiguity and equivocality as found in literature as discussed in Chapter 3.

8.1.4 Reflection

The exploration of using assignment data for the identification of acquisitions of Dutch YTBFs by foreign firms provides an equivocal perspective on the proposed usage of this data. On the one hand, this study proves the possibilities of assignment data. On the other hand, the thesis shows various uncertainties, incompleteness and shortcoming surrounding assignment data. Foremost, assignment data is incomplete. The analyses show that acquisitions can be overlooked, as various acquisitions are not identifiable through assignments. Additional research is needed to study further the magnitude of these implications, as well as to increase understanding and possibly strengthen the understanding with regards to the institutional framework. The methodology, reviews and results presented in this thesis provide opportunities for further research and contributes to the understanding of the usage of patent assignments. Subsequent sub-sections elaborate on contributions, limitations and recommendations for future studies.

The analyses on characteristics illustrate a vivid and varied perspective of the characteristics of the YTBFs, the acquirers, the technology-origins, the technology-relatedness and the post-acquisition activities. Given the identification of a select number of acquisitions, additional research with a larger sample is required to explore underlying relationships between these aspects.

8.2 Theoretical and methodological contributions

Chapters 3 to 5 reviewed the foundations of this research and reflected upon the implications of previous studies and positioned the thesis. In this section, I reflect upon how the thesis contributes both theoretically and methodologically to the discussed fields and studies.

8.2.1 Theoretical contributions

The literature reviews of Chapters 3-5 highlight that there is currently no research that considers the acquisitions of Dutch YTBF specifically, and acquisition through analysing patent assignment data in general. Hence, this research contributed theoretically by exploring these aspects.

The main theoretical contributions find their roots in the field that employs or studies patent assignments. The thesis outlined how acquisitions could be understood from this perspective and proposed terminology accordingly. Additionally, it reviewed specific limitations in the context of acquisitions, which have received little attention yet. Moreover, it was the first study to analyse the usage of such an extensive set of inscriptions of available event authorities in PATSTAT. The study reveals the possible worthiness of using US assignments, which are currently the dominant assignments used in literature. Moreover, it highlights possible event codes that could be relevant for countries not considered by current publications (Appendices C and G).

For innovation-related studies, the research contributed with findings regarding the origin of the technologies and firms' part of these acquisitions. The perspective provided in this study, specifically regarding the overlap in assigned technologies, contributes to the discussion on the origins of innovations. This also contributes methodologically, as this opens up new possibilities for research. Regarding research on acquisitions, the research amplifies rather than unites the equivocality in perspectives and findings.

Lastly, utilising the proposed terminology, the analyses showed that there is an overlap on the level of INPADOC families between possible *direct and indirect* assignments. Additional research is needed to analyse these aspects further. However, the thesis could have implications for current research which only considers M&A data in filtering out irrelevant bare transactions for evidence for the markets for technology, ideas and patents (Appendix A). This since the chain of events in most cases, includes assignments between more firms than part of the narrow acquisition perspective. Ciaramella and colleagues (2017) have additionally used corporate structures to filter out intragroup transactions. However, this thesis implies that not only M&A and corporate structure data needs to be considered, when controlling for acquisitions in patent transfer studies, as was controlled for these. Corroborating evidence on the level of patents and the inclusion of a wide acquisition perspective are necessary in order not to overestimate the bare interactions.

8.2.1 Methodological contributions

The methodology outlined in Chapter 6 contributed through various aspects to the research fields. First, the thesis introduced an approach for how to identify and validate acquisitions by employing assignment data. This methodology can be complementary for other studies, as researchers have been unable to differentiate between acquisitions and stand-alone patent transactions, especially for small firms (see, for example, Serrano, 2010). The methodology and steps can be adapted to suit different lines of inquiry, like acquisitions of large firms and spinning-off of departments. Specifically, for spinning-off, the research contributed by proposing a new perspective on how to analyse origination of firms using assignment data. This methodology allows to analyse such events and put these in perspective, especially regarding a subsequent acquisition. This approach might aid future studies that want to analyse origins of innovation, spin-offs and possible relations to acquisitions.

8.3 Limitations

This study has several limitations that are necessary to discuss and put the results and conclusions into perspective. First, it is unknown what the development of the YTBFs would have been without the acquisition. As the study was exploratory and only a select number of acquisitions were identified, no

analysis regarding the characteristics versus post-acquisition performance was performed. Caution is advised for such explanatory studies as the thesis shows a varied landscape and has highlighted the importance of context, i.e. the acquirer's intentions.

Additionally, regarding the assignment data, the main limitation is data completeness. Here one should bear in mind the self-selection bias of this data type (Ciaramella et al., 2017; Graham et al., 2018b). Since there is little research on the incentives to register ownership changes, it is impossible to infer how much acquisitions are overlooked. Through analysing external information during manual validation, Section 7.4.2 highlighted the fact that acquisitions of YTBFs indeed can be overlooked by employing this data.

Complementarily, the study focuses on YTBFs, which are defined by proprietary technology. This focus means that firms that do not make use of patents (potentially for strategic reasons) or exclusively use other means of intellectual property protection were not considered (Ziedonis, 2004; Ziedonis & Hall, 2001). This limitation affects the translatability of the methodology and findings.

Moreover, the validation was limited to 63.5% of pairs and 78.8% of all observations. I decided to strategically focus on a subset of all assignments since the manual validation procedure proved to be particularly labour intensive and time-consuming. Hence, the analysis was limited to a focused subset of acquisitions identified in a strategic sample. Meaning that, potentially, other acquisitions could be identified using the remainder of the assignment data. Moreover, this limits a full understanding of the usage of patent assignments related to Dutch YTBF acquisitions.

Lastly, there were various complexities in retrieving information on post-acquisition and pre-acquisition performance and other firm-related data, especially for subsumed firms. In general, this had to do with the fact that most of the YTBF were private companies, and there was little information publicly available. Additionally, for one case, the fact that the acquisition happened more than 20 years ago proved to make retrieving information almost impossible (Pangenetics). Information on larger public companies (Crucell, and most acquirers) was more widespread and documented. Furthermore, given the limited sample after validation and data availability, I was cautious with statistically analysing for purposes of cross-comparisons. A larger sample is needed to analyse the relationships between the proposed indicators and allow for a more robust analysis.

8.4 Recommendations for future research

This section outlines the recommendations for future research. These originate in the various discussions provided in this chapter as well as the previous chapters.

A first proposed line of inquiry regards the incentives to document ownership changes. Other authors have called for intensifications of efforts to understand incentives for the registration of ownership changes as well (Ciaramella et al., 2017). This understanding is needed to define possible differences in the propensity to register these changes and the differences between offices and surrounding institutions. Information on this, in turn, aids the research field and understanding of how the patent system is used.

Second, as there are various uncertainties and limitations regarding the data, it is advised for future research to consider combining the presented methodology with other methods to identify acquisitions. A second method to study acquisitions using patent data could be to study applicant changes between various publications[43]. Additionally, other data sources offer opportunities for combinations, including M&A data and trademark assignments (Graham, Marco, & Myers, 2018a; Marco, Myers, Graham, & Apple, 2014)[44]. The combining of various of these methods could allow studying changes by potentially complementary perspectives and methods. Combining methods, in turn,

[43] Changes can be found by APPLT_SEQ_NR and corresponding applicants in PATSTAT.

[44] The usage of trademark assignments might provide different opportunities, as compared to patent assignments. Importantly, trademarks might be more challenging to be separated from the overarching firm as compared to patents. Here it is expected to be unlikely that a firm acquires a brand, but not the related business (as opposed to the case of patents) (Frey, Ansar, & Wunsch-Vincent, 2014).

might provide a complete identification process of acquisitions. Moreover, combining allows for different possibilities of additional indicators and information retrieval, potentially leading to a more integrated overview. In this line, it is advised to study how to further automate the presented methodology. I expect the manual tasks performed in this research highly suitable for further automation, possibly by machine learning and other forms of data processing. This coupled to the proposed (automated) combination with other forms of data might allow for a comprehensive database in the future.

Third, specific to the proposed usage of trademark assignments, I propose various lines of inquiry. The thesis highlighted limitations regarding determining what happened with the YTBFs and their technologies after the acquisition. Here coupling with trademark data might allow insights on the transfers of trademarks, the commercialisation of the acquired services, products and or technologies (Graham et al., 2018a). Moreover, usage of trademark assignments might allow to potentially study or include those firms that do not have patents but do have trademarks (and which could be underrepresented in M&A databases). Furthermore, this allows different tools to characterise the acquirer, acquiring party, the acquisition and the impact. Currently, the USPTO has made their data available online, whereas it is hoped that others follow suit (Castaldi, 2019). Similar to patent assignments, research is advised to study the incentives to register such ownership changes.

Fourth, I challenge other researchers to study cross-border acquisitions in the context of assignment data and the introduced indicators. Regarding the indicators, studies could analyse a different CPC-overlap by taking the co-occurrence of CPC classifications on a patent, or weigh for the occurrence of patents in the definition of CPC-overlap.

The last recommendations regard the standardisation of patent assignment data. The thesis identified various inscriptions, which in turn differed in data completeness. Although the EPO offers some guidance on standardisation, by the grouping of various inscriptions, future research could address the feasibility of (partial) standardised classifications, inscriptions, formatting and procedures for these and similar post-application events. Additionally, specific to PATSTAT, research could look at how PARTY_OLD and PARTY_NEW could be better harmonised. These are not linkable to table TLS206, which limits the standardisation of these attributes. This thesis used research on harmonisation of TLS206 (Magerman, Van Looy, & Song, 2011; Plessis, Looy, Song, & Magerman, 2009) which was easily adapted to function for PARTY_OLD and PARTY_NEW as well. However, for data redundancy reasons, a potential coupling to TLS206 would ease future efforts and prevent duplicate efforts in this endeavour. Improved harmonisation allows for improved understanding of who the current owner of a patent is, and ease research regarding the understanding of the economics of patents.

8.5 Implications and recommendations for public policy

This section presents recommendations and implications for public policy regarding acquisitions and patents. One of the ambitions voiced by the Dutch government is to become the top European ecosystem in terms of start-ups and scale-ups. What is the success factor of this ecosystem? The number of founded companies, the number of kept firms or the number of firms that grow into large independent companies? Although the thesis cannot provide an answer to if foreign acquisitions are preferable, it shows a varied perspective on the acquisitions of (revealed) attractive YTBFs by foreign firms. Hence it is essential to define the success factors of the ecosystem while acknowledging the possible consequences of exits of YTBFs and adjust expectations and strategies on this accordingly (Andersson & Xiao, 2016). Possible changes in the strategy given this definition might be to change the focus from the number of start-ups founded and created in the ecosystem to the number and quality of large firms created by the process (Carpentier & Suret, 2014).

This thesis shows that almost all acquired YTBFs, identified using assignment data, have received subsidies. Consequently, it can be argued that the Dutch government has sponsored innovative activities that have now been accessed by other countries and firms. Interestingly, the government has voiced the importance of the protection of Intellectual Property. However, after foreign acquisitions, this intellectual property is in the hands of foreign firms and this, in turn, could prevent the development of

future competing products and technologies by Dutch firms within the boundaries of this intellectual property (which might have been the single reason for acquisition). Here three recommendations are made for policymakers. The recommendations encapsulate efforts for increasing understanding and data on these exits and a possible way to systematically regard these acquisitions in the context of antitrust policy.

I. To advance understanding of the exits of innovative Dutch firms, specifically YTBFs, it is advised that research and efforts are undertaken to define the magnitude of these exits. The presented thesis provides a start in this direction. However, assignment data proved to have various limitations. The CBS publishes data on the mergers and acquisitions of firms in the Netherlands. However, their available online data does not allow to break down according to the nationality of the acquirer, nor the age of the target firm. In case available at CBS, this could be matched with data from patent registers to define the overall prevalence of acquisitions of YTBFs, including acquisitions by Dutch firms. Moreover, policymakers should consider linking to the Top Sectors, which allows for comparisons. This data, in turn, would allow policymakers to adapt policy tools according to found trends.
II. A second recommendation involves efforts to obtain a better understanding of how subsidies relate to patented technologies and subsequent transfers of these patents to other firms. One possibility to increase understanding of this topic concerning the patent system is the recording of government interest (subsidies and loans) on the level of research that has resulted in patents, in these patents. This recording allows the tracking and quantification of patents related to which the subsidies and loans pertain. In turn, this allows researchers and policymakers to examine how these subsidies result in specific technologies, when underlying patents are transferred through the economy, and what spill-overs such investments have to other technologies and sectors (e.g. citations and new filings with CPC overlap) (Graham et al., 2018b). This registration might aid and inform the proposed option under III and increases understanding of the result of subsidies and the potential adverse effects in the perspective of exits.
III. Antitrust agencies have long been interested in the implications of transactions involving the transfer of assets from one party to another. Intellectual property could be the critical source of competitive advantage, implying that antitrust issues arise when patents transfer from one party to another (Scott Morton & Shapiro, 2013). Moreover, if the post-acquisition innovation performance is influenced by the degree of complementarity of the firm's patent portfolios, it has consequences for how competition authorities should evaluate an efficiency defence by the merging parties and the degree of concentration in post-M&A firms (Marco & Rausser, 2011). Currently, the Dutch antitrust agency (ACM) only considers acquisitions when (1) the two parties both have a turnover in the Netherlands above 30 million ***and*** (2) together have a worldwide turnover above 150 million. For health-related companies, the values are 10 and 55 million, respectively (Autoriteit Consument & Markt, 2019). It can be argued that for smaller or young innovative companies, who are investing in R&D, these acquisitions often will not meet the first criteria. Consequently, the ACM does typically not consider these acquisitions. Therefore, in the light of the studied acquisitions, it is advised for policymakers to study the feasibility and desirability of new antitrust policies aimed at the acquisition of small or young innovative firms. These policies could consider how a proposed acquisition relates to future innovative and economic activities in The Netherlands and the concertation of patents in the acquiring firm (Cunningham et al., 2019; Pires-Alves et al., 2019). There are possibilities for undertaking this strategically, for example, by focusing only on firms that are part of the top sectors. Another option might be to consider the deal value of proposed acquisitions as an indicator of the *val*ue of the acquired firm and future turnover potential.

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Appendix A – The markets for technology, patents and ideas

Chapters 3 discusses firm acquisitions. However, this is not the only channel through which firms can acquire external innovation. The firm can look outside its boundaries and focus on (non-) patented technologies in the market for technology, ideas and patents – and either license or acquire these. Within the institutional framework of Chapter 4 and previous literature discussed in Chapter 5, this alternative perspective is often discussed. Although this is not the focus of the analysis, a short reflection upon these markets is provided for convenience and background information. These markets are often discussed interchangeably, promoting uncertainty around the definition of these concepts.

A.1 Markets for technology

According to Arora and colleagues (2002), the market for technology refers to transactions for the use, diffusion, and creation of technology. These transactions include transactions of full technology packages and patent licensing as well as those involving knowledge and ideas that are not patentable or not patented. Consequently, this relates to the market for *ideas* and *patents*.

A.2 Markets for ideas

The market for ideas framework originates in the work of Gans et al. (2002). According to Natalicchio et al. (2014), this market can best be seen as a virtual marketplace built upon three dimensions; (1) knowledge owners, either individuals or organizations, (2) selling their ideas, to (3) knowledge seekers. According to various authors, this market is characterized by an asymmetry of information, between the two sides of the market (Dushnitsky & Klueter, 2011; Silveira & Wright, 2010). Dushnitsky and Klueter, for example, argue that seekers are often not aware of the full potential of the ideas (2011). To allow for an accurate valuation of these ideas, the owning party should fully disclose their ideas. This disclosure, however, may put owners at risk of misappropriation of their ideas by seekers (Anton & Yao, 2002; Arrow, 1962). This situation is often referred to as the Arrow information paradox (1962), which is a critical issue here (Natalicchio et al., 2014).

A.3 Markets for patents

A fundamental aspect of patents is their ownership transferability (Gäßler, 2016). Transferability is the fundamental backbone of the market for patents, in which these patents are unbundled from ideas and technologies and are characterized as tradable assets[45] (Monk, 2009). The *existence* of this market is argued to stimulate a smaller number of patents to remain unused. This since these can be licensed or traded to firms with better capacity to use the underlying technology (Chesbrough, 2006).

Given the specific nature of patents, this market differs from the market for ideas. Here two effects are differentiated (De Rassenfosse, Palangkaraya, & Webster, 2016). First, the possession of patents helps to assure a current and prospective owner that future rents could be protected. This *appropriation* effect is especially relevant given findings of the Berkeley Patent Survey, stating that one of the most important reasons for young firms to patent is to secure financing (Graham, Merges, Samuelson, & Sichelman, 2009). Complementarily, patents play a significant role in the financing decisions of venture capitalists of young firms (Häussler, Harhoff, & Müller, 2011; Sichelman, 2018). Second, the *disclosure effect*. By definition, all information in a patent is disclosed 18 months after the filing date, and this makes the market less prone to the Arrow Paradox (Häussler et al., 2011; Natalicchio

[45] A different view illustrated in literature is the view that patents are traded as commodities. McDonough (2007) argues that the patent market exists, based on this conceptualization. However, according to Monk (2009), this presumption does not hold since commodities are interchangeable and sold without qualitative differentiation, which is argued not to be the case for patents.

et al., 2014; Serrano & Ziedonis, 2018)[46]. Häussler and colleagues show that not only the patent application but broader information retrievable from the process at the patent office aids in overcoming the asymmetry (2011).

Although disclosure can (partially) overcome information asymmetries, studies suggest that different challenges do continue to be part of the market. For example, established firms prefer to close deals behind curtains, such that owners do not demand overvalued compensation for their patents (Benassi & Di Minin, 2009). Complementarily, Hagiu and Yoffie (2013) and Ziedonis (2004) report that the usage of brokers is partly due to concerns concerning valuation.

[46] There is a strong incentive to disclose the information adequately. Hall and Harhoff report that in almost all patent systems, insufficient disclosure of the invention can lead to revocation of a patent right or the rejection of an application (2012).

Appendix B – PATSTAT tables and attributes

This Appendix lists relevant information on the tables (Table A.1) and attributes (Table A.2) from PATSTAT which are referred to in this thesis. For additional tables and attributes, see (European Patent Office, 2019b, 2019a).

Table B.1. Explanation of PATSTAT tables discussed in the thesis.

Table	Explanation
TLS201_APPLN	Contains key bibliographical data elements relevant to identify the patent application. Most of the elements here can be found on the first page of a patent document. It lists all the available applications in the PATSTAT database and assigns them a unique and stable APPLN_ID.
TLS206_PERSON	Contains information on the persons related to an application. These can be legal persons (enterprises) or natural persons. The domain object person covers both applicants and inventors. An application may have at any point of time multiple applicants, inventors or representatives. These may also change over time. Only applicants are mandatory for an application.
TLS209_APPLN_IPC	Contains all IPC linked to the applications. The set of classifications linked to a single application is a de-duplicated merge of all classifications of the various publication instances linked to the specific application. Here only the latest version of the IPC classifications is used.
TLS211_PAT_PUBLN	Contains information on publications related to an application. At defined stages in the application procedure, publications are issued. There are several types of publications, each for a different purpose.
TLS212_CITATION	Contains information on the links between publications, applications and non-patent literature with regards to citations. This includes the possibility to define forward and backward citations.
TLS224_APPLN_CPC	Contains all CPC linked to the applications. The set of classifications linked to a single application is a de-duplicated merge of all classifications of the various publication instances linked to the specific application. It is important to consider that CPC codes are propagated to all members of the same DOCDB family.
TLS227_PERS_PUBLN	This table links each publication (TLS211_PAT_PUBLN) to its applicants and inventors (e.g. TLS206_PERSON).
TLS231_INPADOC_LEGAL_EVENT	Contains legal status data of granted patents from more than 40 patent authorities worldwide, including the EPO. The Legal Event domain object represents procedural actions which change the (legal) status of an application or a granted patent.
TLS803_LEGAL_EVENT_CODE	Contains all legal event codes which are used in EPO's worldwide legal status database. Similar legal event codes are grouped into legal event categories.

Table B.2. Explanation of PATSTAT attributes discussed in the thesis.

Table	Explanation
APPLN_ID	Application identification number
APPLT_SEQ_NR	An entry with a value 1 to n represents an applicant; an entry with the value 0 does not represent an applicant, but another person (e.g. an inventor). It is possible that there are applications where no applicants are known.
CITED_APPLN_ID	Identifier of a cited application. However, not only applications can be cited, but publications as well. Hence see CITED_PAT_PUBLN_ID.
CITED_PAT_PUBLN_ID	Identifier of a cited patent publication. However, not only publications can be cited, but applications as well. Hence see CITED_APPLN_ID.
CITED_DOCBD_FAMILY_ID	Identifier of the cited DOCDB simple family and uniquely identifies the cited family.
DOCDB_FAMILY_ID	Identifier for the simple family, also called DOCDB family or Espacenet patent family: All applications which are member of the same simple family do have the same priorities. The technical content of these family members is regarded as (almost) identical, so their publications are sometimes called equivalent.
EARLIEST_FILING_DATE	The earliest date of the filing dates of either (1) the application itself, (2) its international application, (3) its Paris Convention priority applications, (4) the applications with which it is related via technical relations or (5) its continuations. This does not include priorities of priorities.
EVENT_AUTH	The national office which has provided the legal event.
EVENT_CATEGORY_CODE	Code of legal event category.
EVENT_CODE	The code which identifies a unique legal event in case it is conjugated with the country code of the application.
INPADOC_FAMILY_ID	Identifier of an INPADOC extended priority family. Here a family means that applications share a priority directly or indirectly via a third application.
PARTY_NEW	The name of the new party. Sometimes contains address information.
PARTY_OLD	Unstructured text containing the prior right holders or former owners. In most cases contains other text; additional names, categorizations and addresses.
PAT_PUBL_ID	Identifier for a patent publication.
PERSON_CTRY_CODE	Country part of the correspondence address of the person or business.
PSN_SECTOR	Assigned sector of the applicant of the patent.

Appendix C – PATSTAT event codes indicating patent ownership change

This Appendix lists all the codes (EVENT_CODE) retrieved from PATSTAT that (might) indicate a change of ownership of patents, which is discussed in Sub-section 6.1.1. The codes refer to different inscriptions made by different authorities. Only the conjugation of event authority and event code is unique. For additional information for each code I refer to the files of the weekly INPADOC updates information of the EPO[47].

Table C.1. PATSTAT codes that indicate an ownership change, ordered per event authority. A * is shown next to each code for which all PARTY_NEW variables were empty for the search-space (32 cases).

Event authority (WIPO country code)	Event codes	Number of assignments for narrow acquisitions
Austria (AT)	PC, TC9K, EEIH*, EIH*	
Australia (AU)	PC, PC1	
Belgium (BE)	CH	
Brazil (BR)	B25A, B25C, B25B, PCR*, PC, GB* PCP*, B25M*, GBR, GBP	9
Switzerland (CH)	SPCP*, SPCM, PUE, PFA, PFUS	18
China (CN)	ASS, C41*, TR01*, CP01*, TA01*, CB02*	22
German Democratic Republic (DD)**	ASS, RPI*, EPAE, EPAA	
Germany (DE)	8327, R081	203
Eurasian Patent Organization (EA)	PC4A*, PD4A*, TC4A*, PC1A*, PD1A	
European Patent Office (EP)	RAP1, RAP2, ITPR, NLS, BECH	253
Spain (ES)	PC2A	10
Finland (FI)	PC, GB, HC, TC, PCU	
France (FR)	TP, AS*, TQ, AU*	65
Great Britain (GB)	COOA, 732E*	
Hong Kong, China (HK)	AS	
Hungary (HU)	HA9A	
Israel (IL)	HP	
Japan (JP)	S111*, R350*, R371*, A711*, R360*, R370*, S131*, S199	
Republic of Korea (KR)	N231*, N234*, N235*, N237, N236	
Lithuania (LT)	PC9A, PD9A*	
Republic of Moldova (MD)	PD4A, PC3A, GB9A, CHPR	
Mexico (MX)	GB, PD	
The Netherlands (NL)	SD, PD, CD, SNR, CNR	13
New-Zealand (NZ)	ASS	
Portugal (PT)	PC4A, PC3A, PD4A, PD3A, PC3K, PD3K	1
Russian Federation (RU)	PC4A*	
Slovenia (SI)	SP73	1
Slovakia (SK)	PC4A	
United States of America (US)	AS	716

* All PARTY_NEW variables were empty for the search-space

** Organization/state does no longer exist.

[47] It can be retrieved by https://www.epo.org/searching-for-patents/data/coverage/weekly.html.

Appendix D – Additional categorization of ownership transfer of USPTO assignments

This Appendix lists all the defined rules for the conveyance-type categories of the additional categorization of USPTO assignments, as discussed in Sub-section 6.1.3.1. This categorization allows filtering out all non-ownership-change-related assignments. For the table below, it is essential to understand the concept of wildcards in SQL. A wildcard character is used to substitute one or more characters in a string. The percentage symbol % represents zero, one or more characters, whereas _ represents exactly one character.

Table D.1. Category clues for different assignment types of USPTO assignments.

Category	Type examples	Example of hints used for category allocation
Administrative	Address change	"Change of address", "Address change", "Alternative% name"
	Name change	"Correct name", "Change of name"
	Correction	"Should be", "Correction", "Missing", "Error"
	Inventor agreement	"Add inventor", "Speci% inventor"
	Translation	"Translation"
Assignment	Acquisition	"Acquisition"
	Transfer	"Asset transfer agreement", "Ownership%%change", "Transfer"
	Affidavit	"Affidavit"
	Amalgamation	"Amalgamation"
	Assignment of assignor	"Assignment:", "Assignment of assignor's interest"
	Conversion	"Conversion"
	Merger/demerger	"Merger", "Demerger", "Merging"
	Declaration	"Declaration"
	Gift	"Gift agreement"
	New owner	"Ownership agreement", "New% owner", "Entire% Interest"
	Patent sale	"Patent% sale", "Sale% patent"
	Conveyance	"Conveyance"
	Nunc Pro Tunc	"Nunc"
Judicial	Bankruptcy	"Bankrupt", "Liquidation", "Liquidator"
	Nullification	"Annulment", "Nullification", "Termination"
	Deceased	"Inheritance", "Deceased"
	Court	"Court order", "Invalid", "Settlement"
Security	Security interest	"Security interest", "For security"
	Lien	"Lien"
	Mortgage	"Mortgage"
	Release	"Security release", "Removal% Security"
	Pledge	"Pledge"
	Collateral	"Collateral"
Other	50 percent	"50", "shared", "1/2", "Distribution", "Fifty", "One_half"
	Data service	"Data service"
	R&D	"Research and development", "Research agreement"
	Service	"Service agreement"
	License	"License"
	Government	"Government"

Appendix E – Additional firm allocation: rules and cases

This Appendix lists all the defined rules and cases for additional firm allocation, which is discussed in Sub-section 6.1.3.3. This allocation allows filtering out all non-firm related assignments. For the table below, it is essential to understand the concept of wildcards in SQL. A wildcard character is used to substitute one or more characters in a string. The percentage symbol **%** represents zero or more characters, whereas _ represents one character.

Table E.1. Additional rules and cases for rule and case-based sector allocation of company sector.

Type	Assigned as company where PARTY_OLD or PARTY_NEW are like
Additional rules	'% AG,%', '% B V.', '% B V', '% B. V', '% B. V', '% BV', '% CV', '% DIGITAL', '% EHF', '% EN ZOON', '% FUND%', '% ICT%', '% INDUSTRY', '% INTELLECTUAL PROPERTY', '% IP %', '% IP', '% NV,%', '% OYI%', '% RESEARCH%', '% S.AR.L.', '% S.AR.L', '% SCIENTIFIC%', '% U. A.', '% U.A.', '% U.A.%', '% UA', '% V. O. F.', '% Z O.O.', '%A.R.T.', '%A.R.T.%', '%AB;%', '%AG;%', '%AGENT%', '%B V,%', '%B.V %', '%B.V,%', '%B.V. ', '%B.V. %', '%B.V.,%', '%BANK %', '%BV;%', '%C V,%', '%C. V. ', '%C. V. %', '%C.V,%', %C.V.(NL)',%C.V.,%', '%C.V', '%CENTRUM%', '%CHEMISTRY%', '%COMMUNICATION%', '%CONCEPT',%CONCEPT%', '%CONTRACTS%', '%COOPERAT%', '%ELECTRONICS%','%ELEKTRIK%', '%ENZYM%', '%FABRIEK%', '%GESELLSCHAFT%','%HOLDING%', '%INC,', '%INC,%', '%INC,%', '%INNOVAT%', '%INTELLECTUAL%', '%INTERNATIO%', '%LICEN%', '%LLP,%', '%LP,%', '%LTD.%', '%MANUFACTURING%', '%MATERIALS%', '%N.V,%', '%N._V.,%', '%N.V,%', '%N.V.,%', '%NEDERLANDSE%', '%NV.', '%NV.%', '%PACKAGING%', '%PCE%', '%PHARMA%', '%PHARMACEUTICALS%', '%PLC,%', '%RADIO%', '%REFRIGERATION%', '%S.AS.', '%S.AS.%', '%S.E.%', '%S.L.U.%', '%SARL%', '%SENL)%','%SEMICONDUCT%', '%SERVICE', '%SERVICE%', '%SOCIET%', '%SOLUTIONS%', '%SYSTEM%', '%TECH', '%TECH%', '%TECHNIEK%', '%TECHNOLOG%', 'B V %', 'CREDIT %', 'INNOVAT%', 'NEDERLANDSE%', 'VOF %', '% B V.', '% B V', '% B. V', '% B. V', '% BV', '% CV', '% DIGITAL', '% EHF', '% EN ZOON', '% FUND%', '% GESELLSCHAFT%', '% ICT%', '% INDUSTRY', '% INTELLECTUAL PROPERTY', '% IP %', '% IP', '% RESEARCH%', '% S.AR.L.', '% S.AR.L', '% SCIENTIFIC%', '% U. A.', '% U.A.', '% U.A.%','%UA','%V.O.F.','%ZO.O.', '%BANK%','%C.V','%CENTRUM%', '%COOPERAT%','%FABRIEK%','%HOLDING%',%MATERIALS%', '%NEDERLANDSE%', '%TECHNIEK%', 'CREDIT %', 'NEDERLANDSE%', 'VOF %', '% IP', '% I.P.', '%S.A R.L%', '%S.AR.L%', '%SAR.L%', '%LIMITED LIABILITY%', '%B..V.%', '% G.V.', '% S.A', '% S.V.', '% SA', '% G.V.', '% P.T.E.', '% P.T.E', '%AKTIENGESELLSCHAFT%'
Additional clues	'TNO', 'FCI', 'FCI%', 'FCI,%', '% TNO%', '% TNO', 'TNO %', 'SARA LEE%', 'DOUWE EGBERTS%', 'ARGENX%', 'MCI%', 'IMEC%', 'PREXL%', 'RTC-COMPELEC%', 'BIMED%', '% THOMSON%', 'CITIBANK%' , 'ROUSSEL-UCLAF%' , 'ACCENTURE%', '%BREVETS%', 'TAKE5%', 'EQUISTAR%', 'FOX%', 'BIOMERIEUX%', 'PCE', 'STRATOS', 'TRIMEDION', 'COMOTEC', 'LLOYD WISE', 'CSIR', 'STK %', 'CARL ZEISS %', 'BY CONIN%', '%RIJK ZWAAN%', '%LIQUAVISTA%', '%VAN DOORNE%S%'

Appendix F – CPC overlap after acquisition

This Appendix lists the overlap of CPC for the situation after the acquisition, as discussed in Sub-section 7.3.2.1

Table F.1. CPC overlap after acquisition.

YTBF	CPC overlap with acquirer before acquisition		CPC overlap difference absolute % with AA acquirer and BA YTBF*	
	Full CPC	Main group	Full CPC	Main group
Mogen International	55.24%	69.23%	-11.43%	-7.69%
Pangenetics	82.35%	100.0%	-35.29%	-10.00%
Crucell	34.71%	78.87%	-10.44%	-19.72%
Advanced Laser Separation	56.00%	85.71%	-20.00%	-14.28%
Prosensa	66.23%	91.67%	-42.86%	-33.34%
Profibrix	44.44%	23.08%	-31.75%	-3.85%
GreenPeak Technologies	16.87%	40.00%	-13.25%	-4.44%
Liquavista	88.61%	95.83%	-6.33%	0.00%
Xpand Biotechnology	30.77%	47.62%	-30.77%	-47.62%
Polymer Vision	79.67%	74.19%	-32.79%	11.29%
Silicon Hive	95.76%	100.0%	-1.69%	0.00%
Geotate	84.38%	75.00%	-67.19%	-45.83%
Priv-ID	59.26%	33.33%	-59.26%	-33.33%
SyncNow*	0.00%	0.00%	0.00%	0.00%
Babybloom Healthcare	57.14%	100.0%	-14.29%	-75.00%
Euclid Vision Technologies	91.30%	80.00%	-21.74%	0.00%
Lanthio Pharma	30.77%	57.89%	-25.64%	-26.31%
Sapiens Steering Brain Stimulation	98.28%	100.0%	-30.17%	-17.24%
Medimetrics	11.96%	33.33%	-11.96%	-33.33%

* *AA* refers to applications after acquisition, *BA* refers to applications before acquisition. For this the EARLIEST_FILING_DATE was used.

Appendix G – Assignment data results

Table G.1. Recording of ownership changes per patent authority for the acquired YTBF from the narrow perspective. A 'Y' indicates that the specific inscription has been used. An additional 'E' indicates that all PARTY_OLD variable was empty for the related assignments for the specific case, this means that the assumption made under Sub-section 6.1.3.2 was relevant. In case there is no 'E' there was no empty PARTY_OLD.

YTBF	Patent authority and respective code (see Table C.1 for more information and abbreviations of countries)														
	BR	CH		CN	DE		EP				FR	NL	PT	SI	US
	B25A	PUE	PFA	ASS	8327	R081	RAP1	RAP2	NLS	BECH	TP	PD	PC4A	SP73	AS
Mogen International					YE		YE		YE						Y
Pangenetics															
Crucell							YE	YE							Y
ALSI						Y					YE				Y
Prosensa			Y			Y	YE	YE							Y
Profibrix															
GreenPeak Technologies						Y					YE				Y
Liquavista							YE								Y
Xpand Biotechnology							YE								Y
Polymer Vision	YE			Y		Y	YE	YE							Y
Silicon Hive				Y		Y	YE	YE		YE	YE				Y
Geotate							YE	YE							Y
Priv-ID						Y	YE	YE			YE				Y
SyncNow				Y			YE								Y
Babybloom Healthcare	YE					Y		YE			YE	Y			Y
Euclid Vision Technologies															Y
Lanthio Pharma		Y				Y	YE	YE					YE	YE	Y
Sapiens Steering Brain Stimulation							YE								Y
Medimetrics						Y	YE	YE			YE				Y

Table G.2. Recording of ownership changes per patent authority for spinning off or merging of the firms. A 'Y' indicates that the specific inscription has been used. An additional 'E' indicates that the PARTY_OLD variable was empty for all the specific assignments and that the assumption made under Sub-section 6.1.3.2 was relevant.

YTBF	Patent authority and respective code (see Table C.1 for more information and abbreviations of countries)											
	CH		CN	DE		EP			FR	ES	SI	US
	PUE	PFA	ASS	8327	R081	RAP1	RAP2	NLS	TP	PC2A	SP73	AS
Crucell		Y				YE						Y
Prosensa					Y							
Liquavista					Y	YE	YE			YE		Y
Polymer Vision			Y			YE	YE					Y
Silicon Hive			Y		Y	YE	YE					Y
Geotate						YE	YE					Y
Priv-ID						YE						Y
SyncNow			Y	YE	Y	YE	YE	YE				Y
Euclid Vision Technologies												Y
Lanthio Pharma	Y				Y	YE	YE		YE	YE	YE	Y
Sapiens Steering Brain Stimulation						YE						Y
Medimetrics					Y	YE	YE		YE			Y

Appendix H – Identified relevant acquisitions without assignments

The following table includes information on Dutch YTBF acquisitions by foreign firms, which were identified in the process of validation, but which were not represented by the patent assignment data.

Table H.1. Overview of acquisitions of Dutch YTBF by foreign firms. Ordered by founding year.

YTBF	Founding year	Acquisition year	Acquirer	Nationality acquirer
Bmeye	2005	2012	Edwards Life Sciences	America
Epyon	2005	2011	ABB	Switzerland-Sweden
Youmedical	2005	2015	Trimb Healthcare	Sweden
Mendix	2005	2018	Siemens	Germany
Anteryon	2006	2019	Jingfang Optoelectronics	China
Teletrax	2008	2015	4C insights	American
Nexguard Labs	2008	2016	Kudelski	Switzerland
Layar	2009	2014	Blippar	United Kingdom
NP Komplete Technologies	2009	2012	Sagantec	America
SecurityMatters	2009	2018	ForeScout	America
Anteverta	2010	2015	Maury Microwave	America
Clinical Graphics	2010	2016	Zimmer Biomet	America
Innoluce	2010	2016	Infineon	Germany
Innovalens	2010	2019	Johnson & Johnson	America
Authasas	2011	2015	Micro Focus	America
Dezima	2012	2015	Amgen	America
Acerta Pharma	2012	2015	AstraZeneca	Sweden
Scyfer	2013	2017	Qualcomm	America