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THE SUCCESS FACTORS OF TECHNOLOGY-SOURCING THROUGH MERGERS & ACQUISITIONS – AN INTUITIVE META-ANALYSIS

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Abstract:

With mergers & acquisitions playing an increasingly important role in today's business world, academic research has strived to follow this trend by investigating their underlying causes and consequences. For a long time this research focused on the analysis of the financial effect of mergers & acquisitions as measured by market value or debt level. Thus, despite being a major vehicle of industry concentration and method of reallocation of resources, the technological impact of mergers & acquisitions remained comparatively underinvestigated for a long time. This, however, has changed in recent years. With the prevalence of the resource-based view and its derivates as the dominant logic in analysing today's knowledge-intensive industries the focus shifted towards the technological aspects of mergers & acquisitions. With both mergers & acquisitions and innovation being centrepieces of competitive strategies in the modern economy, it is of central importance to understand the consequences of mergers & acquisitions for the innovative potential of firms. After more than twenty years of research in this field, it is time to take stock of what we know about the technological impact of mergers & acquisitions and its determinants. The aim of this paper is to provide an overview of the respective research by performing a meta-analysis of the empirical studies in the field. The intuitive setup allows for a detailed analysis of the individual determinants while differentiating between the impact on innovation input and output. We identify the knowledge characteristics of the partnering firms as being essential to the technological success of mergers & acquisitions. Important implications for policy makers, practitioners and future research are derived.

Introduction

For a long time the phenomenon of mergers and acquisitions was almost exclusively explained by the traditional motives such as synergies, growth, diversification, and internationalisation, with a special focus on shareholder value and the pursuit of management objectives (Coase (1937); Penrose (1959); Williamson (1979); Roll (1986); Ravenscraft und Scherer (1989); Morck et al. (1990); Trautwein (1990)). While these motives might explain a large part of the merger activity before the 1990s, they fail to explain the more recent upsurge of merger activity in high-technology industries such as ICT or pharmaceuticals (Hagedoorn (2002)). These industries are characterised by rapid technological change, a shortening of the product life-cycle and intensifying global competition. In this competitive landscape continuous innovation constitutes the most important source of value creation and long-term growth. Thus, a firm's performance and survival does not solely depend on its size, market share, diversification and international reach, but on its ability to continuously introduce new or improved products and services (Hitt et al. (1994); Christensen et al. (1998); Foster und Kaplan (2001) Cefis und Marsili (2006)).

However, due to rapid technological change as well as the complexity and interdisciplinary of new high-technology products and processes, individual firms are increasingly unable to keep up with developments in all the relevant technological fields (Granstrand und Sjolander (1990)). As a consequence, they can no longer exclusively rely on their internal R&D to stay competitive (Rindfleisch und Moorman (2001)). Often the required technological capabilities and knowledge are created outside the firm or even in different industries and countries. This has led to an increasingly open innovation process in which the internal R&D-efforts are complemented by the exploration and exploitation of technological opportunities and knowledge sources outside the respective firm's own boundaries (Veugelers (1997); Veugelers und Cassiman (1999); Hagedoorn (2002); Chesbrough (2003a); Nicholls-Nixon und Woo (2003); Lane und Probert (2007); Parmigiani (2007)). With this external sourcing of technological knowledge, incumbent firms aim to compensate for their deteriorating R&D productivity and the overcapacity resulting from expiring patents (see Danzon et al. (2004); Higgins und Rodriguez (2006)). The available options range from licensing agreements to strategic alliances and joint ventures to the full integration of the target firm by means of mergers & acquisitions (Veugelers und Cassiman (1999); Vanhaverbeke et al. (2002); Hagedoorn und Duysters (2002b); Chesbrough (2003a); Nicholls-Nixon und Woo (2003); Van De Vrande et al. (2006)). Although strategic alliances may still be the prevailing option in highly dynamic and uncertain

environments, mergers and acquisitions are continuously gaining in importance as a means to access external knowledge (Hennart und Reddy (1997); Vanhaverbeke et al. (2002); De Man und Duysters (2005); Dyer et al. (2004); Hagedoorn und Duysters (2002c); Villalonga und McGahan (2005)). This is also reflected in the rising number and value of high-technology mergers and acquisitions both in absolute and in relative terms as compared to the other strategic options (Garette und Dussauge (2000); see also ThomsonReuters SDC mergers and acquisitions database). This is confirmed by empirical findings suggesting that technological motives play an increasingly important role in M&A decisions and even constitute a central explanation factor for the latest merger waves (Chakrabarti et al. (1994); Gerpott (1995); De Man und Duysters (2005)). Thus, Mergers and acquisitions are increasingly seen as a strategic instrument for tapping into the external 'market for technology' (Arora et al. (2001)).

This increasing importance of M&A as an strategic instrument of external technology sourcing notwithstanding, the economic research for a long time focused either on the relationship between market concentration and innovation at the industry level (Schumpeter (1942); Arrow (1959); Nelson (1959); Kamien und Schwartz (1982); Acs und Audretsch (1987); Cohen und Levin (1989); Geroski und Pomroy (1990); Aghion et al. (2005)) or on the relation between internal R&D efforts and the respective innovation output (Griliches und Mairesse (1981); Griliches et al. (1982); Hall et al. (1986); for an overview see Griliches (1990)). At the same time the management literature focused mostly on shareholder value or short-term performance of M&A (Jensen und Ruback (1983); Caves (1989); Ravenscraft und Scherer (1989); for an overview see King et al. (2004)). The technological success of mergers and acquisitions and its determinants were, on the other hand, barely taken into account – baring a few notable exceptions (Armour und Teece (1980); Hall (1988; Hall et al. (1990; Hitt et al. (1991b)).

This, however, has changed in recent years. Starting in the 1990s an increasing number of economic and management studies have addressed the impact of mergers and acquisitions on the technological performance of the partnering firms as well as the various factors determining this effect. These studies come from such diverse fields as human resources, strategic knowledge and technology management, organizational science, finance, corporate control or innovation economics. Accordingly, the perspectives taken in these range from the analysis of the individual inventors or the characteristics of the underlying knowledge-bases to the integration process and resource transfer following the transaction to the overall impact on the industry structure. While this proliferation of research perspectives has widened our understanding of the manifold facets of mergers and acquisitions and their influencing

factors, it also impedes the deduction of more general implications. This is aggravated even further by the fact that these studies come to rather mixed conclusions concerning the technological impact of mergers and acquisitions and their determinants. This multitude of recent studies and their respective outcomes thus urgently need review in the form of a comprehensive survey of the state of knowledge in this field of research.

The aim of this paper is to take stock of what we know about the determinants of the technological impact of mergers and acquisitions. To this end we perform an intuitive meta-analysis of the 35 most prominent studies focusing on the technological dimension of mergers and acquisitions. The intuitive design of this analysis allows us not only to identify the most important determinants of the technological success of mergers and acquisitions, but also to assess the direction of their influence while differentiating between their impact on the innovation input and output of the merged firm. The determinants identified in this analysis concern the acquirer, the target, and the relationship between them. Due to their prevalence in the respective studies as well as their importance in this context, the main focus of this meta-analysis will be on the knowledge characteristics of the partnering firms.

Theoretical Background

Traditional Theories

The traditional fields of M&A-research, such as industrial economics, financial theory, management theory and transaction cost theory for a long time ignored the technological aspects of mergers and acquisitions (see Trautwein (1990) for an overview of the traditional motives). Instead, a major concern of the research in industrial economics was the question of whether mergers and acquisitions create, destroy or merely redistribute economic value through market concentration and the realisation of economies of scale and scope (Scherer (1980); Barton und Sherman (1984); Mueller (1985); Scherer und Ross (1990); Chatterjee et al. (1992)). The financial theory in turn focused on the realisation of tax advantages (Hayn (1989)), risk diversification (Markowitz (1952); Mueller (1969); Smith und Schreiner (1969); Levy und Sarnat (1970); Salter und Weinhold (1979); Amihud und Lev (1981); Shleifer und Vishny (1991)) or the realisation of financial gains through the acquisition of undervalued targets (Steiner (1975); Ravenscraft und Scherer (1987)). Management theoretical explanations, on the other hand, built on agency theoretical considerations in explaining mergers and acquisitions through the pursuit of personal goals or hubris on the part of management (Ross (1973); Jensen (1986); Roll (1986); Bruner (1988);

Morck et al. (1990)). Finally, the literature on the transaction costs dealt with the costs arising from market transactions and the advantageousness of their internalization through mergers and acquisitions (Williamson (1970); Teece (1982); Williamson (1985)).

While these theories contribute to our understanding of the rationale behind the merger and acquisition activity in general, they have difficulty explaining the fact that mergers and acquisitions are a cyclical phenomenon that have historically occurred in industry-specific waves. In order to explain this periodical and industry-specific character of mergers and acquisitions several authors simply referred to external shocks such as economic booms and recessions or technological and regulatory changes (see for example Jensen (1993); Mitchell und Mulherin (1996); Andrade und Stafford (2004)). These external shocks are often industry specific and can lead to excess capacities or other inefficiencies in the current allocation of resources that are adjusted through mergers and acquisitions. Thus, such external shocks could explain the differences in merger and acquisition activity across industries. However, they neither explain the merger and acquisition activity within industries, nor the observable differences in the success of these transactions. Why do some firms within an industry participate in mergers and acquisitions while others don't? Why are some of these transactions more successful than others? The main reason why the aforementioned theories are unable to adequately address these questions can be seen in their underlying assumption of homogeneous firms. Due to this homogeneity assumption and the resulting equilibrium price on the market for corporate control, merger and acquisition activity as well as their success can only be explained by external factors. However, since the general conditions within a certain industry at a certain point in time are identical for all firms, the occurrence and success of intra-industry mergers and acquisitions can only be explained through the existence of differences on the firm-level. Thus, in order to assess the advantageousness of mergers and acquisitions as compared to alternative strategic options (i.e. internal and market solutions, alliances or joint ventures) and to identify the determinants of their success, we need a theoretical framework that explicitly takes into account the heterogeneity and idiosyncratic characteristics of the individual firms. Accordingly, it was only with the establishment of the resource based view and its derivates – especially the knowledge based view – as a principal perspective in innovation economics and management that the technological impact of mergers and acquisitions and its determinants became a central aspect of academic research.

The Resource-Based and Knowledge-Based View

In the resource based approaches the assumptions of homogeneous firms and the full mobility of resources are abandoned in favour of heterogeneous actors and the immobility of strategic resources. The firm is seen as an idiosyncratic bundle of resources, knowledge, competences and capabilities whose composition and strategic fit eventually determine its competitiveness (Penrose (1959), p. 149; Dierickx und Cool (1989); Barney (1991); Peteraf (1993); Grant (1996b)). The differences in these idiosyncratic resource bundles also explain the performance differences between firms from the same industry (Penrose (1959)). In order to generate a competitive advantage, these strategic resources have to be immobile, non-substitutable and imperfectly imitable (Mahoney und Pandian (1992); Amit und Schoemaker (1993); Peteraf (1993); Teece et al. (1997)). Otherwise competitors would be able to erode competitive advantages nearly frictionless by reproducing the underlying resource bundles (Barney (1991)). It is these characteristics of strategic resources that make mergers and acquisitions the superior strategy for their external sourcing. Only mergers and acquisitions allow bringing entire bundles of resources, knowledge, competences and capabilities under unified control (Penrose (1959), pp. 135ff.; Nelson und Winter (1982), p. 65). Thus, the heterogeneity of firms with regard to their resource endowment and the superiority of certain resource bundles not only explain the performance differences between firms of the same industry but also the intra-industrial merger and acquisition activity and their success.

This is especially true for high-technology industries in which intangible resources such as technological knowledge, competences and dynamic capabilities play a central role. Since intangible assets such as technological knowledge fulfil the aforementioned requirements of strategic resources especially well (Barney (1991); Amit und Schoemaker (1993); Peteraf (1993)) they constitute a major source of competitiveness in these innovation-driven industries. In order to become and stay competitive a firm has to continuously broaden and adapt its knowledge-base and competences to meet the challenges resulting from the technological evolution and the ever changing market conditions. This central importance of technological knowledge and the processes of its generation, augmentation and adaptation are at the heart of the knowledge-based approach. While the classical resource-based view interpreted knowledge as just one type of strategic resource, the knowledge-based approach considers knowledge to be the primary source of innovativeness and competitiveness (Prahalad und Hamel (1990); Grant (1991); Amit und Schoemaker (1993); Henderson und Cockburn (1994); Spender und Grant (1996)). In this perspective the firms is seen as the place where knowledge is

generated, integrated and stored (Grant (1996b)). The underlying assumption is that the firm outmatches the market in coordinating and providing these knowledge related activities (Kogut und Zander (1992)). Thus, the firm provides the organizational framework within which new knowledge is generated, implemented and stored more efficiently than within other organizational settings (Kogut und Zander (1992)). This makes organizational learning and innovation the central processes and the basis of sustainable competitive advantages within the knowledge-based view (Nonaka und Takeuchi (1995); Grant (1996b); Spender (1996); Eisenhardt und Santos (2002); Coff (2003); Nonaka und Von Krogh (2009)).

Organizational Learning and Recombinant Innovation

Organizational learning as well as innovation generally comprises both the exploitation of the existing knowledge and the exploration of new technological fields (March (1991)). While the former normally consist of the local search for incremental improvements of existing products and processes, the latter aims at the generation of radically new solutions (Nelson und Winter (1982); Dewar und Dutton (1986); Damanpour (1991); Rosenkopf und Nerkar (2001); Dahlin und Behrens (2005)). A common feature of both types of learning and innovation, however, is the importance of recombining complementary knowledge elements (Henderson und Clark (1990); DeCarolis und Deeds (1999); Fleming (2001); Rothaermel (2001)). This understanding of innovation is not new to economic thinking. Schumpeter, for example, states in his book *Theory of Economic Development* that *"To produce other things, or the same things by a different method, […] means to combine these materials and forces differently"* (Schumpeter (1934), p. 65) and infers in his later work on *Business Cycles* that *"[…] innovation combines components in a new way, or [..] consists in carrying out new combinations."* (Schumpeter (1939), p. 88). This view was also taken up by Nelson and Winter who assert that *"[…] innovation in the economic system [...] consists to a substantial extent of a recombination of conceptual and physical materials that were previously in existence."* (Nelson und Winter (1982), p. 130).

While exploitation is associated with lower technological and market uncertainty associated with innovation (Cohen und Levinthal (1990)), its recombinant potential is limited by the number of heterogeneous knowledge elements available in the current knowledge base (Ahuja und Katila (2001)). Once all possible combinations of the available knowledge elements are tried and tested, the knowledge base will dry out (Kim und Kogut (1996)). To overcome this 'competency trap' and the resulting technological lock-in requires expending great effort to broaden the knowledge base (Levinthal und March (1981); Levitt und March (1988); Arthur (1989); Leonard-Barton

(1992)). In a world of rapid technological change and increasing complexity of new products and processes this poses a serious threat to the technological and economic competitiveness of the firm, especially in dynamic high-tech industries. Additionally, new technological solutions in these industries are often the result of combining different knowledge fields (Prahalad und Hamel (1990)), which necessitates the integration and combination of complementary technologies (Levinthal (1997); Fleming (2001); McGrath (2001); Rosenkopf und Nerkar (2001)). Accordingly, the process of organizational learning and innovation also requires the exploration of new technological fields (March (1991)). Decisive for the sustainability of a firm's innovativeness is, thus, the balance between the exploration of new knowledge and its subsequent exploitation, or, in other words, *"[…] the relation between the exploration of new possibilities and the exploitation of old certainties"* (March (1991), p. 71).

While exploitation mainly takes place within the firms' internal R&D departments, the exploration can take place either internally or externally. The internal development of new technological competences, however, is resource intensive and time consuming. Since timing is often essential in introducing novelties (Abell (1978); Tyre und Orlikowski (1994)) and the required technological knowledge is often generated and stored outside the firm boundaries, "*the ability to exploit external knowledge is thus a critical component of innovative capabilities"* (Cohen und Levinthal (1990), p. 128). With mergers & acquisitions being one strategic alternative of this open innovation strategy (Chesbrough (2003b); Chesbrough et al. (2006)), it is essential to understand the determinants of their technological success.

The intuitive Meta-Analysis

The aim of the following meta-analysis is to identify the determinants of the technological success of mergers and acquisitions as well as the direction of their respective influence. In order to achieve these aims we develop and apply an intuitive procedure that allows for a low level of aggregation and a high accuracy concerning the individual variables. The analysis is structured as follows: After describing the selection criteria and the observable trends in this field of mergers and acquisitions research we categorize the analysed studies according to their central research question or hypothesis. This categorization allows us to analyze and interpret the impact of the different variables within the respective research context. This is important since the same variable can have a very different impact on, for example, the behaviour and productivity of individual inventors on the one hand and the integration process or resource transfer on the other. After discussing the individual studies within their

context we present a short summary of the central findings for each category. In the next step we analyze the impact of the most relevant determinants over all studies. In doing so, we identify the overall impact as well as its direction for every variable. The results are interpreted using the theoretical arguments proposed in the respective papers. Finally, we analyse the overall impact of mergers and acquisitions on the innovativeness of the new entity. In doing so we differentiate between the impact on the innovation input as it is measured by R&D expenditures, R&E intensity, or R&D productivity and the respective innovation output as it is measured by the patent activity or the number of newly introduced products. This distinction between the impact on the innovation input and the impact on the innovation output is necessary because these two variables are affected quite differently by mergers and acquisitions. A reduction in R&D spending, for example, can also be the result of increased efficiency due to the merging of the two firms with their respective knowledge and capabilities (Ahuja und Katila (2001)).

Using R&D-input data without simultaneously controlling for R&D-output data is, however, problematic in the context of mergers and acquisitions. Since the realization of synergies is one of the major motives for technological mergers & acquisitions, the reduction of redundant and duplicate R&D efforts and resources can be expected. What we observe if these cut-backs do not lead to a decrease in R&D-output is a higher R&D efficiency, not a decrease in innovativeness. While R&D input is suited to measure the innovation efforts or orientation of a firm, the investigation of the actual innovativeness in the sense of introducing new products or services requires the use of output data. Efficiency, in turn, can only be addressed by including both, input- and output-data. In light of this argument, it is surprising how many studies focus exclusively on input to measure the post-merger innovativeness of a firm. Following this procedure, firms that are actually less R&D-efficient could be mistaken for being more innovative.

The Selection of the Relevant Studies

In order to identify the relevant studies to investigate the determinants of the innovation impact of mergers & acquisitions we applied a series of selection criteria:

The definition *of Mergers & Acquisitions* underlying this paper does not include Joint Ventures, Management Buyouts or Leveraged Buyouts. Thus, studies exclusively focusing on such transactions were not considered.

To ensure the *innovation focus* of the studies we included only those studies that focus on the impact of M&As on innovation either directly (R&D input and output measures) or indirectly (e.g. resource transfer, fluctuation of key innovators) in at least one hypothesis or central research question. Since the aim of this meta-analysis is the identification and analysis of the determinants of the technological success of mergers

& acquisitions we only included studies that go beyond the use of a binary M&A variable by including knowledge base, firm or context characteristics as explanatory variables.

To ensure the *quality* of the studies we included only those studies that were published in an academic journal following a blind review process.[1]

And finally, to ensure the *actuality* of the studies, we concentrated on studies that were published after the year 1980.[2]

Applying these criteria we identified and included a total of 33 studies. For the sake of clarity and comprehensibility of the respective determinants we categorize these studies according to their main identifying features. Such features are the central research question or hypothesis (e.g. M&A propensity, resource transfer or degree of integration), the main independent variables used to test these hypothesis (e.g. characteristics of the knowledge base or financial indicators), as well as the level of analysis (e.g. key inventors, firm or industry level). The final sample of studies included is summarized in table 1.

[1] The only exception is the study of Hall (1987). This study was included because it is one of the ground-breaking studies in the field. It was published as a working paper of the renowned National Bureau of Economic research (NBER) and cited well over 150 times at the time of writing.

[2] This criteria takes into account that M&As before the eighties were for the most part neither technologically motivated nor analyzed from this perspective.

Table 1: Selected studies.

Category	Study	Sample Size	Period	Industries	Countries
Key-Inventors	Ernst and Vitt (2000)	61 inventors	1980-1989	Mechanicals, Electrics, Chemicals	Germany
	Kapoor and Lim (2007)	54 M&As	1991-1998	Semicondutor	USA
	Paruchuri et al. (2006)	3933 inventors	1979-1994	Pharmaceuticals	Global
Knowledge Base	Ahuja and Katila (2001)	1287 M&As 72 Acquirers	1980-1991	Chemicals	USA, Europe, Japan
	Armour and Teece (1980)	100 Acquirers	1951-1975	Petrolium	USA
	Cassiman et al. (2005) & (2006)	31 M&As 62 Acquirers	1987-2001	Medium- & Hightech	USA, Canada, Europe
	Cloodt et al. (2006)	2429 M&As 347 Acquirers	1985-1994	Hightech	North America, Europe, Asia
	Desyllas and Hughes (2010)	2624 M&As 573 Acquirers	1984-1998	Hightech	USA
	Hagedoorn and Duyster (2002)	201 M&As 35 Acquirers	1986-1992	Computer	USA, Europe, Asia
	Higgins and Rodriguez (2006)	160 M&As	1994-2001	Biopharmaceuticals	15 countries with focus on USA
	Makri et al. (2010)	95 M&As	1996	Pharmaceuticals, Chemicals, Electronics	Global
	Ornaghi (2009)	27 M&As	1988-2004	Pharmaceuticals	USA, Europa, Japan
	Prabhu et al. (2005)	35 Acquirers 157 M&As	1988-1997	Pharmaceuticals	USA with global targets
	Steensma and Corley (2000)	95 M&As	1993-1994	Medium- & Hightech	USA

M&A Propensity	Cefis (2010)	4604 M&As 2913 Acquirers	1994-2002	Manufacturing	Netherlands
	Danzon et al. (2007)	165 M&As 383 Acquirers	1988-2001	Pharmaceuticals, Biotech	Global
	Hall (1987)	2519 Acquirers	1976-1985	Manufacturing	USA
	Jones et al. (2000)	188 M&As	1990er	19 Industries	12 countries
Integration, Resource Transfer, and Control Mechanism	Bresman et al. (1999)	42 M&As 15 Acquirers	1927-1990	All	Swedish buyers internat. targets
	Capron et al. (1998)	253 M&As 190 Acquirers	1988-1992	Manufacturing	North America, Europe
	Gerpott (1995)	92 M&As	1988	Manufacturing	Germany
	Grimpe (2007)	35 M&As	1998-2001	Medium- & Hightech	Germany
	Hitt et al. (1996)	250 Acquirers	1985-1991	Manufacturing	Global
	Puranam et al. (2003)	207 M&As 49 Acquirerss	1988-1998	IT Hardware	USA
	Puranam et al. (2006)	207 M&As 49 Acquirers	1988-1998	IT Hardware	USA
	Puranam and Srikanth (2007)	97 M&As 43 Acquirers	1988-1998	ICT, Pharmaceuticals	Global with focus on USA
	Chakrabarti et al. (1994)	325 M&As 86 Acquirers	1978-1987	Manufacturing	USA & Germany
Financials	Hall (1990)	2500 Firms	1976-1987	Manufacturing	USA
	Hitt et al. (1991a) & (1991b)	191 M&As	1970-1986	29 Industries	Global
	Valentini (2011)	159 M&As	1988-1996	Medical Devises, Photographic Equipment	USA
Industry	Bertrand and Zuniga (2006)	50.000 M&As	1990-1999	Manufacturing	14 OECD countries

Trends in Technology Focused M&A Research

Before analysing the effect of the individual determinants we first seek to identify some overall trends in the technology focused M&A research.

In considering the year of publication we observe a significant increase in the number of studies investigating the technological impact of mergers & acquisitions. In addition to the availability of the relevant data and analytical software this can also be attributed to the increasing practical and theoretical importance of this aspect of mergers & acquisitions – especially in the fast growing high-tech industries. This is also reflected in a shift in the industries analysed. While older studies predominantly focus on manufacturing, more recent studies have focused increasingly on the highly dynamic ICT, pharmaceuticals and biotechnology industries. In these industries technological resources and knowledge are of central importance, making them a critical aspect of any strategic decision such as mergers & acquisitions. Concerning the dependent variable used to measure the technological success we observe that the more traditional input measures such as R&D expenditures are increasingly complemented or even substituted by output measures like patent activity or the number of newly introduced products. This trend can partly be ascribed to the improved data availability and the development of appropriate analytical methods and software to analyse high data volumes. Concerning the sample size and sample period or the methodology there are no clear trends detectable, despite the advances in the IC technologies. Concerning the regional coverage the existing empirical studies focus almost exclusively on the so called triadic countries of Europe, the USA and Japan. Again, this can be explained by the availability and consistency of the relevant data.

In general it can be concluded that the advancements in handling complex data resulted in the identification of more conditional relationships. Whereas earlier studies tended to investigate the overall impact of mergers & acquisitions on the innovation performance of the firms and industries involved, irrespective of the context and their characteristics, more recent studies seek to identify and analyse the determinants of this relationship on the individual deal level. These determinants can be financial, strategic or organisational aspects of the partnering firms. However, due to their great importance for competitiveness in today's business world, it is increasingly the knowledge bases of the partnering firms that come into focus. Accounting for this trend we also focus on the knowledge-based determinants in the following meta-analysis.

Analysis of the Results within the Categories

Key Inventors

Focusing on the lowest possible level of analysis Ernst und Vitt (2000), Paruchuri et al. (2006) and Kapoor und Lim (2007) investigate the impact of mergers & acquisitions on the fluctuation and productivity modifications of the individual inventors. Summarizing the respective results it appears that mergers & acquisitions have a negative impact on both, the retention as well as the productivity of the acquired inventors. Thus, many inventors leave their former employer after it was merged or acquired and those who stay often exhibit a significant drop in their productivity (patenting activity). This detrimental impact of mergers & acquisitions is, however, mitigated by a number of factors: both, the fluctuation as well as the drop in productivity are aggravated by differences in the R&D culture between the partnering firms (Ernst und Vitt (2000), Paruchuri et al. (2006)) and the integration of the target into the acquiring firm (Paruchuri et al. (2006). Factors that attenuate the negative impact of mergers & acquisitions are the technological relatedness (Ernst und Vitt (2000); Paruchuri et al. (2006); Kapoor und Lim (2007)) and the market relatedness ((Kapoor und Lim (2007)) of the partnering firms. While the integration of differing R&D cultures results in serious disruptions or incisions on part of the acquired inventors, the possession of related or complementary knowledge leads to a greater effort in the integration and retention of the knowledge holders and, as a consequence, to a higher motivation and lower fluctuation on part of the acquired inventors. Additionally, a well-balanced relatedness of the technological knowledge promotes the inter-organisational knowledge exchange and mutual learning and, thus, increases productivity. The results concerning the role of the relative size of the target are less conclusive. While Ernst und Vitt (2000) as well as Paruchuri et al. (2006) find a less negative impact for relatively small targets, Kapoor und Lim (2007) come to the opposite conclusion. While the former argue with the disruption of internal processes and routines due to differing internal control- and compensation systems, the latter stress the stronger influence that a relatively large target has during the integration process. Paruchuri et al. (2006) also show that all these relations are mitigated by individual factors such as the social status and embeddedness of the individual inventors. They also find that technologically motivated mergers and acquisitions have a less detrimental impact. The latter is explained by the closer attention that is paid to innovation related resources in such transactions. This is a notion that is also confirmed by studies focusing on the knowledge characteristics of the partnering firms.

Knowledge Base

Some of the more recent studies focus on the knowledge characteristics of the partnering firms to explain the technological impact of mergers & acquisitions. Concerning the **motive of the transaction** they find that while technologically motivated transactions have a positive impact on the R&D input and output (Cassiman et al. (2005)), non-technological transactions have either a non-significant (Ahuja und Katila (2001)) or a negative impact (Cloodt et al. (2006)) impact. This is explained by the attention paid to the technological resources during the integration process. If they are in the centre of management focus, as is the case in technologically motivated transaction, they can be preserved and integrated properly and, thus, contribute to the ex post performance. If they are not the subject of particular attention, however, the disruptive effects of the integration process might render the potential synergies void.

Another determinant of the technological success of mergers & acquisitions is the **absolute and relative size of the acquired knowledge base**. Here, the effect of acquiring and integrating a large knowledge base is conditional on its relative size (i.e. the size of the acquired knowledge base in relation to the size of the acquirer's knowledge base) (Ahuja und Katila (2001); Cloodt et al. (2006); Puranam und Srikanth (2007)). With the size of the knowledge base being an indicator for the absorptive capacity (Cohen und Levinthal (1989); Cohen und Levinthal (1990)) and the potential for recombinant innovation (Schumpeter (1934); Henderson und Clark (1990); Hargadon und Sutton (1997); Fleming (2001)) this result is explained as follows: While the absolute size of the acquired knowledge base has a positive effect on the acquirer's innovativeness by increasing its absorptive capacity as well as its potential for recombinant innovation, the same argument also defines the limits of this relation. That is to say, if the scope of the acquired knowledge exceeds the current absorptive capacity of the acquirer, he will not be able to identify, evaluate and integrate the relevant knowledge properly. In this case the disruptive effects of the integration process will exceed the potential benefits associated with broadening the knowledge base.

Another set of indicators for the absorptive capacity and the potential for recombination is the **breadth and depth of the acquirer's knowledge base**. While the breadth refers to the technological diversification and, thus, captures the absorptive capacity and potential for cross-fertilization and recombination across technological fields, the depth basically measures the technological specialisation in terms of the absorptive capacity and recombinant potential within a rather focused field of expertise. Both variables, although only considered in the two studies by Armour und Teece (1980) and Prabhu et al. (2005)) exhibit a positive effect on the ex post innovativeness of the acquirer.

Yet another determinant of both the absorptive capacity and the potential for recombinant innovation, is the **technological relatedness** of the merged knowledge bases. This determinant was investigated in most of the studies focusing on the knowledge characteristics of the partnering firms. Building on cognitive science and memory research the authors argue that the integration and utilization of new knowledge is facilitated by its relatedness to the already existing knowledge. This emphasizes the cumulative and path-dependent character of knowledge in the sense that new knowledge always builds on pre-existing knowledge (Cohen und Levinthal (1990); Kogut und Zander (1992); Dosi (1982)). Acquiring new knowledge (i.e. learning) therefore necessitates some prior knowledge in the same or a related technological field. This dyadic perspective and context-specificity of the absorptive capacity concept is what Lane und Lubatkin (1998) call the 'relative absorptive capacity'. Since the scope of the current knowledge base and its relatedness with the acquired knowledge determine the absorptive capacity of the acquirer, it is necessary to consider the characteristics of both knowledge bases when analysing the absorptive capacity (see Dyer und Singh (1998) for strategic alliances and Ahuja und Katila (2001) in the context of mergers & acquisitions).

While the absorptive capacity continuously increases with the relatedness of the two knowledge bases, the relationship with the potential for recombinant innovation is non-linear. A certain degree of relatedness or overlap is necessary in order to combine the different knowledge elements. If the acquired knowledge is too similar to the pre-existing one, however, it merely generates redundancies without providing room for new combinations. So, while the acquisition of technologically unrelated knowledge exceeds the absorptive capacity of the acquirer, the acquisition of too closely related knowledge does not contribute to the absorptive capacity nor to the potential of recombinant innovation and learning. Most studies therefore find an inverted U-shaped relationship between technological relatedness and the ex post innovativeness (e.g. Ahuja und Katila (2001); Cloodt et al. (2006); Prabhu et al. (2005)).

Other variables that were investigated by studies in this category include the R&D intensity (e.g. Hagedoorn und Duysters (2002a); Higgins und Rodriguez (2006); Makri et al. (2010)), the market relatedness of the partnering firms (e.g. Cassiman et al. (2005); Hagedoorn und Duysters (2002a); Higgins und Rodriguez (2006); Ornaghi (2009); Desyllas und Hughes (2010); Makri et al. (2010)), the existence of prior relations (e.g. Cassiman et al. (2005); Paruchuri et al. (2006); Ernst und Vitt (2000)) as well as the acquirer's experience in conducting mergers & acquisitions (see e.g. Steensma und Corley (2000); Hagedoorn und Duysters (2002a); Makri et al. (2010)). The respective results, however, are inconclusive.

M&A Propensity

An important contribution to the understanding of the causes and consequences of M&A activity was the consideration of the firm's propensity to act as a buyer or seller in the market for corporate control (e.g. Hall (1988); Jones et al. (2001); Danzon et al. (2007); Cefis (2010) but also Higgins und Rodriguez (2006); Ornaghi (2009); Desyllas und Hughes (2010)). This not only allows us to control for the ex ante differences between the merging firms (i.e. unobserved heterogeneity), but also sheds some light on the underlying motives. Summarizing the most important results concerning the M&A propensity, there is some evidence for the use of mergers & acquisitions as a strategy of external knowledge sourcing. Accordingly, firms with an old product and patent portfolio tend to appear more often as buyers in the market of corporate control (e.g. Higgins und Rodriguez (2006); Danzon et al. (2007); Ornaghi (2009)). Besides closing the temporary gaps in their internal product pipeline this external technology sourcing strategy also serves to complement or substitute for internal R&D efforts. Since complementary and substitutive knowledge exert a very different influence, it is hard to generalize the overall effect that these technologically motivated transactions have on internal R&D efforts. Thus, it is argued that firms that regularly appear as buyers in the market for corporate control tend to use mergers & acquisitions as a substitute for internal R&D while firms using mergers & acquisitions as an instrument of technological diversification rather aim to complement their internal R&D efforts. Accordingly, the results concerning the relationship between the internal R&D efforts and the propensity to merge or acquire are somewhat inconclusive. While some studies find that firms with a strong internal R&D are more frequently engaged in mergers & acquisitions (e.g. Higgins und Rodriguez (2006); Cefis (2010)), others find the opposite relation (e.g. Hall (1988), Jones et al. (2001); Danzon et al. (2007); Desyllas und Hughes (2010)). Thus, the question of whether merging and acquiring firms aim to complement or substitute their internal R&D effort cannot be conclusively answered. The hypothesis that firms in financial distress are more frequently engaged in mergers & acquisitions is only supported by Higgins und Rodriguez (2006) and Danzon et al. (2007). The explanatory power of the firm size and industry characteristics are also rather inconclusive: While Hall (1988), Cefis (2010), and Desyllas und Hughes (2010) find that larger firms are more active as buyers, this is not supported by Higgins und Rodriguez (2006) and Ornaghi (2009). They find that mergers & acquisitions are more common in high-tech industries. That, however, is not supported by Hall (1988). Although several studies consider the determinants of the M&A propensity, only Danzon et al. (2007) employ it as an independent variable in explaining the effect on innovativeness.

Target Integration, Resource Transfer and Control Mechanism

Another research focus of the resource based management literature on mergers & acquisitions is the integration of the target firm into the acquirer and the organization of the knowledge and resource transfer between them. In this view, mergers & acquisitions are first and foremost seen as a means of reallocating resources. The results concerning the integration strategy, however, are rather inconclusive. While some studies find a positive effect of target integration (e.g. Grimpe (2007)), the majority of studies find a negative or ambiguous effect, depending on the dependent variable (e.g. Bresman et al. (1999); Puranam et al. (2003); Puranam et al. (2006); Puranam und Srikanth (2007)). Depending on the selection of explanatory variables the studies also come to mixed conclusions concerning the effectiveness of different integration management measures like the implementation and composition of integration teams (Gerpott (1995)) or management measures to facilitate communication and trust building (Gerpott (1995); Bresman et al. (1999); Grimpe (2007)). The centralization of the corporate R&D, in turn, has an overall positive effect on innovativeness (Chakrabarti et al. (1994); Gerpott (1995); Grimpe (2007)) as does the speed of integration (Chakrabarti et al. (1994)). The same is true for the implementation of a strategic control system as opposed to financial controls (Hitt et al. (1996)). However, even these management focused studies have to admit that some of the most important success factors are beyond the direct influence of the management. The most important of these success factors is that the partnering firms have similar sizes (Chakrabarti et al. (1994); Gerpott (1995); Bresman et al. (1999); Puranam et al. (2006)). This is explained by the similarity of the organizational structure and internal processes. A positive effect is also found for the market relatedness of the firms (Gerpott (1995); Puranam et al. (2006)), while technological uncertainty, differences in the R&D culture and a high level of formalization exert a negative effect (Chakrabarti et al. (1994)). Interestingly, the M&A experience of the acquirer is consistently found to negatively affect the integration and resource transfer (Gerpott (1995); Puranam et al. (2006)). This could be explained through the development of standardized integration procedures that do not consider the individual characteristics of the respective deals (Chakrabarti et al. (1994)). While the above mentioned factors influence the appearance and scope of the knowledge transfer, its direction is largely determined by the relative resource strength of the partners (Capron et al. (1998)).

Financials and Debt Ratio

Another stream of literature focuses on financial indicators in investigating the impact of mergers & acquisitions on the innovative performance. In this respect Hall et al.

(1990) find that it is not the transactions per se that causes a decline in the ex post R&D efforts but the acquirer's debt ratio - irrespective of its origin. Contrary to this (Hitt et al. (1991a; Hitt et al. (1991b)) find that mergers & acquisitions lead to a reduction of R&D expenditures and patent activity irrespective of the associated debt ratio and financial performance of the acquirer. In a more recent study Valentini (2011) finds that the debt ratio particularly and explicitly affects the quality of ex post patent activity rather than the quantity. He explains this by the pressure to realize immediate R&D results which often come at the expense of their quality. Summarizing these results, there is no clear link between the financial situation of the partnering firms and the ex post innovativeness of the new entity.

Industry Level

The only study investigating the impact of M&A on innovativeness on the industry level is Bertrand und Zuniga (2006). Distinguishing between low, medium and high technology industries as well as between national and international transaction they do not find evidence of a significant impact of the merger & acquisition activity on the R&D intensity at the aggregated industry level (see also Hall (1987); Hall et al. (1990)).

Impact Analysis of the Individual Explanatory Variables

In the following we will analyse the individual impact of the most important explanatory variables on the innovativeness of the resulting firm.[3] Since mergers & acquisitions are likely to affect the innovation input differently than the innovation output, we analyze these effects separately before assessing the combined impact on both types of innovation measures. In doing so we distinguish between invention input indicators such as R&D spending or intensity and patent and product based indicators for the respective invention output. In cases in which one study investigates both, the impact on innovation input and output, it is treated as two separate studies. The corresponding results are summarized in table 2. Starting with the number of studies that actually included the respective explanatory variable we identify the percentage of studies that find a positive, neutral (non significant or conditional) and negative impact of the explanatory variables on the respective dependent variable (i.e. invention input, innovation output, and overall impact) (see appendix 1-3). Summarizing these results we are able to assess the overall trend concerning the direction of the effect that the individual determinants have on innovativeness.

[3] Therefore we only included variables that were included in at least two studies. The only exception are variables that complement the interpretation of other variables.

Table 2: Impact on Innovation Input, Invention and Innovation Output, and Overall Impact.

Dependent Variable		Impact on Input		Impact on Output		Overall Impact	
Categories of Independent Variables	**Independent Variables**	**# of Studies**	**% positive minus % negative**	**# of Studies**	**% positive minus % negative**	**# of Studies**	**% positive minus % negative**
M&A	M&A	9	**-22%**	8	**-25%**	17	**-24%**
Motive	Technological Motive	2	**100%**	2	**100%**	4	**100%**
	Non-technological Motive	1	**0%**	2	**-50%**	3	**-33%**
Knowledge Base	Absolute Size of Knowledge Base	0	**0%**	3	**0%**	3	**0%**
	Relative Size of Acquired Knowledge Base	0	**0%**	2	**-100%**	2	**-100%**
	Breadth of Knowledge Base	1	**-100%**	1	**0%**	2	**-50%**
	Depth of Knowledge Base	0	**0%**	1	**100%**	1	**100%**
	Technological Relatedness	3	**0%**	13	**54%**	16	**44%**
	Technological Relatedness^2	0	**0%**	4	**-100%**	4	**-100%**
R&D Characteristics	Type of Knowledge (codified)	0	**0%**	1	**-100%**	1	**-100%**
	Uncertainty	1	**-100%**	1	**0%**	2	**-50%**
	R&D Expenditures (Acquirer)	2	**100%**	9	**11%**	11	**27%**
	R&D Expenditures (Target)	2	**100%**	1	**100%**	3	**100%**

Continuation of **Table 2**

Dependent Variable		Impact on Input		Impact on Output		Overall Impact	
Categories of Independent Variables	**Independent Variables**	**# of Studies**	**% positive minus % negative**	**# of Studies**	**% positive minus % negative**	**# of Studies**	**% positive minus % negative**
Product and Patent Portfolio	Prior Products or Patents (Acquirer)	0	**0%**	3	**100%**	3	**100%**
	Prior Products or Patents (Target)	0	**0%**	5	**40%**	5	**40%**
	Desperation Index (Expiring Patents and Old Products)	0	**0%**	1	**100%**	1	**100%**
Firm Age & Firm Size	Firm Age (Acquirer)	1	**100%**	1	**-100%**	2	**0%**
	Firm Age (Target)	0	**0%**	3	**-33%**	3	**-33%**
	Absolute Firm Size Acquirer	6	**17%**	8	**50%**	14	**36%**
	Absolute Firm Size Target	1	**0%**	5	**-40%**	6	**-33%**
	Relative Firm Size (Target/Acquirer)	2	**50%**	3	**0%**	5	**20%**
	Similarity in Size (Acquirer/Target)	0	**0%**	1	**-100%**	1	**-100%**
M&A-Experience	M&A Experience	3	**-67%**	6	**0%**	9	**-22%**
Prior Relations	Prior Relations	1	**0%**	3	**0%**	4	**0%**
Market Relatedness & Diversification	Market Relatedness	5	**0%**	9	**11%**	14	**7%**
	Diversification / Conglomerate M&A	2	**-50%**	6	**-67%**	8	**-63%**

Continuation of **Table 2**

Dependent Variable		Impact on Input		Impact on Output		Overall Impact	
Categories of Independent Variables	**Independent Variables**	**# of Studies**	**% positive minus % negative**	**# of Studies**	**% positive minus % negative**	**# of Studies**	**% positive minus % negative**
Financial Firm Characteristics	Tobin's Q (Market Value/Book Value)	1	**100%**	1	**0%**	2	**50%**
	Liquidity	1	**0%**	1	**-100%**	2	**-50%**
	Accounting Performance (ROI etc.)	4	**-50%**	3	**-33%**	7	**-43%**
	Leverage, Dept Ratio	3	**-33%**	3	**0%**	6	**-17%**
	Leverage Growth / Unprofitability	3	**-67%**	1	**100%**	4	**-25%**
Integration & Organisation	(Degree of) Integration	0	**0%**	6	**0%**	6	**0%**
	Autonomy of Target	0	**0%**	1	**100%**	1	**100%**
	R&D Decentralisation	2	**-50%**	1	**0%**	3	**-33%**
	R&D Centralization	1	**100%**	0	**0%**	1	**100%**
Integration Management	Intra-organisational Meetings	1	**0%**	2	**50%**	3	**33%**
	Communication & Information Sharing	2	**-100%**	1	**100%**	3	**-33%**
Geographic & Cultural & Institutional Distance	Difference in R&D Culture	1	**-100%**	1	**-100%**	2	**-100%**
	International M&A	5	**0%**	6	**50%**	11	**27%**
	Domestic M&A	2	**-50%**	1	**0%**	3	**-33%**

Concerning the isolated impact of **mergers & acquisitions** we find a negative impact on both, innovation relevant inputs and outputs. Of the nine studies investigating the direct impact of mergers & acquisitions on the innovation input two find a positive, three a neutral and four a negative relationship (see Annex 1). Summing up there is an excess of two studies that find a negative impact over those that find a positive impact. Expressed as a percentage of the total nine studies including this variable this figure corresponds to a negative trend of 22%. The results concerning the impact on the innovation output as well as the overall impact are to be interpreted accordingly. However, these results concerning the isolated impact of mergers & acquisitions stem from the inclusion of a binary dummy variable that assumes a value of one in case of M&A activity and a value of zero in case of no such activity. Thus, the respective results do not control for the variables that actually determine whether the impact is positive or negative.

One such variable is the underlying **motive** of the transaction. Here the results support the hypothesis that while technologically motivated transactions have a positive impact on ex post innovativeness, the opposite is true for non-technologically motivated transactions (e.g. Capron und Mitchell (1998); Ahuja und Katila (2001); Cassiman et al. (2005); Cloodt et al. (2006)). This is explained by the attention paid to the innovation relevant resources during the integration process and their contribution to the expansion of the knowledge base. Following this reasoning, technological transactions enhance the acquirer's innovativeness by providing economies of scale and scope and increasing its potential for recombinant innovation (Henderson und Cockburn (1996); Ahuja und Katila (2001); Fleming (2001)). Non-technological M&A, on the other hand, contribute less to the innovative potential of the buyer and, thus, do not contribute significantly to its innovativeness (e.g. Capron und Mitchell (1998); Ahuja und Katila (2001)). Additionally, if accessing technological resources is not a motive of the transaction, less or no special attention will be paid to their integration. Since the integration process generally absorbs a significant amount of managerial attention and often disrupts the established routines and processes (see Haspeslagh und Jemison (1991); Hitt et al. (1991b); Hitt et al. (1996)), such non-technological transactions can also have a negative effect on innovativeness (e.g. Cloodt et al. (2006)).

Another factor determining the innovation impact of mergers & acquisitions are the characteristics of the acquired knowledge such as its absolute and relative size, its breadth and depth, and its technological relatedness to the acquirer's knowledge base.

The effect of the **absolute size** of the acquired knowledge base, as well as most of the other knowledge-based determinants, was only investigated in studies using the

innovation output (i.e. patent activity) as a dependent variable. Of the three studies including this variable Ahuja und Katila (2001) find a positive and Puranam und Srikanth (2007) a non-significant impact on innovativeness. Cloodt et al. (2006), in turn, find a positive effect for the first two years and a even stronger negative effect for the third and fourth year following the transaction. This somewhat contradicts the theoretical reasoning according to which the acquired knowledge base expands the acquirer's own knowledge base and with it his potential to realize synergies in terms of economies of scale and scope (Henderson und Cockburn (1996)), the potential for recombinant innovation (Fleming (2001)), and his absorptive capacity (Cohen und Levinthal (1989); Cohen und Levinthal (1990)). All of these effects should positively affect the acquirer's innovativeness. These assumptions are also confirmed by studies that incorporated the absolute size of the acquirer's knowledge base. Puranam und Srikanth (2007) as well as Desyllas und Hughes (2010) find a positive relationship between the acquiring firm's knowledge base and its innovation performance. In accordance with the finding of Cloodt et al. (2006) the latter find this effect to vanish after the first two years following the acquisitions. This could indicate that the positive effect disappears once the 'low hanging fruits' – in terms of the most obvious recombinations of the existing knowledge elements – are realised. Another explanation could be the fast depreciation of the relevant knowledge, especially in high-technology industries (Henderson und Cockburn (1994, (1996)); Cloodt et al. (2006)).

More important than the absolute size is the **relative size** of the acquired knowledge base. Here the results clearly indicate that the absorption – i.e. the identification, integration and utilization – of a relatively large knowledge base exceeds the respective capacity of the acquirer. The larger the acquired knowledge base is compared to the acquirer's knowledge base, the more difficult, time consuming and risky these steps will be (Haspeslagh und Jemison (1991); Chakrabarti et al. (1994)). Accordingly, we find a significant negative relationship between the relative size of the acquired knowledge base and the post-merger innovativeness in both studies including this variable (Ahuja und Katila (2001); Cloodt et al. (2006)).

Another set of variables which captures a slightly different aspect of the absorptive capacity as well as the potential for recombinant innovation is the **breadth and depth** of the acquirer's knowledge base. A broad knowledge base means that it covers many different technological fields (i.e. the number of patent classes covered), while the depth or concentration is a measure of the expertise in the respective technologies (i.e. the number of patents in each patent class). Thus, these concepts basically measure the technological diversification or specialization of the firms. A broad knowledge base indicates absorptive capacity in a broader technological field, thus allowing the buyer to

choose from a broader spectrum of potential targets and integrate even diverse knowledge (Prabhu et al. (2005)). A technologically specialized knowledge base, in contrast, indicates a high absorptive capacity only in certain technological fields. This enables the buyer to identify, evaluate and integrate the most promising candidates within a rather restricted group of potential targets (Prabhu et al. (2005); Desyllas und Hughes (2010)). Following the transaction, a broad knowledge base provides more opportunities for exploration in the sense of cross-fertilization and the (re)combination of knowledge elements from different technological fields (Cohen und Levinthal (1990); Kogut und Zander (1992); Henderson und Cockburn (1994); Bierly und Chakrabarti (1996)). A more specialized knowledge base, on the other hand, promotes exploitation by recombining knowledge elements of the same or closely related technological fields (March (1991); Hamel (1994)). While the results confirm the expected positive impact that the depth of the knowledge base has on the innovation output (Prabhu et al. (2005); Desyllas und Hughes (2010)), there is an overall non-significant effect of the breadth of the knowledge base on the innovation output (Prabhu et al. (2005)) and a negative one on the innovation input (Armour und Teece (1980)). Prabhu et al. (2005), for example, confirm a generally positive effect of the breadth of the knowledge base on the innovation output. This effect, however, is non-significant in the M&A context. This result could be explained by the overstretching of the firm's resources, which prevents a proper integration and exploitation of the acquired knowledge (Wernerfelt und Montgomery (1988); Prabhu et al. (2005)).

An important mediating factor of both, the absorptive capacity and the recombinant innovation, is the technological **relatedness** of the merged knowledge bases. Technological relatedness refers to the similarity of the knowledge bases in terms of the different technological fields covered therein (Lubatkin, 1983; Lane und Lubatkin (1998); Ahuja und Katila (2001); Hagedoorn und Duysters (2002a); Cassiman et al. (2005)). It is widely acknowledged that learning as a cumulative and path-dependent process requires a certain degree of relatedness of the new knowledge with the already accumulated one (Dosi (1982); Cohen und Levinthal (1990); Kogut und Zander (1992); Grant (1996b)). According to the concepts of absorptive capacity, the extent to which new knowledge can be identified, integrated and applied depends to a large extent on how related it is to the already existing knowledge (Henderson und Cockburn (1996); Mowery et al. (1996); Lane und Lubatkin (1998)). The technological relatedness therefore constitutes a prerequisite of absorbing new knowledge: "*The premise of the notion of absorptive capacity is that the organization needs prior related knowledge to assimilate and use new knowledge.*" (Cohen und Levinthal (1990), p. 129). Thus, the degree of relatedness indicates to what extent the knowledge of one firm is of use to

another firm by complementing its own knowledge base (Ernst und Vitt (2000)). Since technological relatedness also indicates similar R&D processes and search heuristics it should also facilitate the integration process (Lane und Lubatkin (1998); Puranam et al. (2006); Nooteboom et al. (2007)). This also increases the motivation and decreases the fluctuation of the R&D personnel (Ernst und Vitt (2000); Paruchuri et al. (2006); Kapoor und Lim (2007)). After successful integration, a related knowledge base should also provide for synergies in terms of economies of scale and scope, a shortened time to market and the realisation of larger and broader R&D projects (Cassiman et al. (2005); Gerpott (1995); Henderson und Cockburn (1996); Larsson und Finkelstein (1999); Bierly et al. (2009)). Finally, the existence of a certain overlap or links between the elements within the merged knowledge base also increases the potential for cross-fertilization and recombinant innovation (Henderson und Cockburn (1994); Bierly und Chakrabarti (1996); Fleming (2001); Hargadon (2002)). However, the literature on organisational learning also indicates that the acquisition of too closely related knowledge contributes little to the acquirer's knowledge base and the potential for recombination (Baysinger und Hoskisson (1989); Kogut und Zander (1992); Ahuja und Katila (2001)). On the contrary, such identical knowledge merely produces redundancies and increases the probability of technological rigidity and lock-in (Cyert und March (1963); Dosi (1982); Leonard-Barton (1992); Bierly und Chakrabarti (1996)). *"The observation that the ideal knowledge structure for an organizational subunit should reflect only partially overlapping knowledge complemented by nonoverlapping diverse knowledge suggests an organizational trade-off between diversity and commonality of knowledge [..]."* (Cohen und Levinthal (1990), p. 134). Theory thus suggests an inverted U-shaped relationship between technological relatedness and its impact on innovation. This inverted U-shaped relationship was confirmed by all studies testing this hypothesis (Ahuja und Katila (2001); Prabhu et al. (2005); Cloodt et al. (2006); Kapoor und Lim (2007)). Furthermore, 56% of all studies including the concept of technological relatedness find it to be positively related to innovativeness, whereas only 13% find a negative relation.

Concerning the relationship between the a prior **R&D intensity** of the partnering firms and their ex post innovation input, the results show the expected positive effect (Hall (1987); Hall et al. (1990)). However, with respect to the innovation output the results are less conclusive: while Cloodt et al. (2006) and Makri et al. (2010) find a positive impact, Steensma und Corley (2000), Ahuja und Katila (2001), Prabhu et al. (2005), Puranam et al. (2006), Puranam und Srikanth (2007) a neutral or non-significant impact and Hagedoorn und Duysters (2002a) as well as Higgins und Rodriguez (2006) even a

negative impact. This could indicate that mergers & acquisitions in R&D intensive high-tech industries are mostly used to fill gaps in the acquirer's product pipeline.

The importance of the ex ante **product and patent portfolio** of the partnering firms was only investigated for their impact on the innovation output. Here, the results show that prior success in patenting or introducing new products have a positive effect on the ex post innovativeness of the combined firm. That is especially true for the respective experience of the acquirer (Ahuja und Katila (2001), Cloodt et al. (2006); Prabhu et al. (2005)). Higgins und Rodriguez (2006)) also find that firms struggling with an old product portfolio and the expiration of important patents (desperation index) gain more form mergers & acquisitions than firms that are in a better position in this respect. Whether this effect is sustainable or whether mergers & acquisitions are merely a quick fix for the short run remains unclear.

Besides the aforementioned characteristics of the knowledge base there are several context variables that also influence the technological success of mergers & acquisitions. Amongst those the absolute and relative **firm size** are the most frequently analysed. The corresponding results indicate that the size of the acquiring firm is overall positively related to its ex post innovativeness (e.g. Armour und Teece (1980); Hitt et al. (1991b); Chakrabarti et al. (1994); Steensma und Corley (2000); Ahuja und Katila (2001); Prabhu et al. (2005); Puranam et al. (2006); Cloodt et al. (2006). Others however find a neutral (e.g. Hitt et al. (1991b); Puranam und Srikanth (2007); Cefis (2010)) and some even a negative relationship (e.g. Gerpott (1995); Hitt et al. (1996); Cefis (2010)). The size of the target firm, however, is generally not significant (Gerpott (1995); Bresman et al. (1999); Prabhu et al. (2005); Puranam und Srikanth (2007)) or negatively related to the ex post innovativeness ((e.g. Ernst und Vitt (2000); Puranam et al. (2006)). The same applies to so called 'mergers of equals'- i.e. the merger of similarly sized partners with equal rights (Hagedoorn und Duysters (2002a)). In considering these results, the finding that the relative size of target has an overall positive effect on the ex post innovative performance is somewhat surprising. This result is explained, however, by the observation that the studies actually finding a positive effect look at either the retention and performance of the target firm's inventors (Kapoor und Lim (2007)) or the resource transfer following the acquisition (Gerpott (1995)) as dependent variable. The other studies incorporating this variable either find a neutral or negative relation (Capron und Mitchell (1998); Paruchuri et al. (2006); Makri et al. (2010)). The negative effect of acquiring large targets is further aggravated by the **age** of the partnering firms. This could be explained through the organisational rigidities and inertia that develop over time and obstruct the integration of the two firms (e.g. Leonard-Barton (1995); Puranam et al. (2006); Puranam und Srikanth (2007); Cefis

(2010)). According to these results, the most promising strategy is the acquisition of relatively small and young targets by comparatively large acquirers.

M&A experience has been shown to have a significant influence on the performance and management decisions during integration (Haleblian und Finkelstein (1999); Zollo und Singh (2004)). Following the learning curve argument, the acquirer's experience in undertaking mergers & acquisitions should allow for a better planning of the transaction and should help to deal with the problems and difficulties occurring during the integration process. Furthermore, experience in mergers & acquisitions should enable the acquirer to better assess the value of the target firm (Hitt et al. (1998)). Surprisingly, the results we find in our analysis indicate the opposite: Only 11% of the studies find a positive (learning) effect of M&A experience, while the majority of 56% percent finds no significant effect and another 33% find a negative effect. This overall negative trend, however, stems from the impact on the innovation input (e.g. Gerpott (1995); Chakrabarti et al. (1994)), whereas the innovation output is not significantly affected (e.g. Ernst und Vitt (2000); Steensma und Corley (2000); Hagedoorn und Duysters (2002a); Puranam und Srikanth (2007)). Struggling to come up with an explanation of this rather counterintuitive result, most authors follow Chakrabarti et al. (1994) who refer to the adoption of standardised procedures and a high degree of formalisation that ignore the individual character and unique circumstances that characterise every deal.

Another factor that should help to reduce uncertainties related to the deal and, thus, ease the disruptions during integration, is the existence of **prior relations** between the partnering firms. Such relations could range from informal knowledge exchange at conferences and meetings to more formal (e.g. contractual) cooperation such as joint R&D projects or licensing agreements (Ernst und Vitt (2000); Cassiman et al. (2005); Paruchuri et al. (2006)). The results, however, do not support this hypothesis. Instead there is no significant relationship between the existence of prior relations and the ex post innovativeness.

The **market relatedness** is frequently included to capture the similarity of routines, processes, and products (e.g. Cassiman et al. (2005); Kapoor und Lim (2007)) as well as a similar management style and technological logic (e.g. ; Prahalad und Bettis (1986); Bettis und Prahalad (1995); Desyllas und Hughes (2010)). According to the theoretical reasoning this should have a positive influence on the absorptive capacity as well as the potential for economies of scale and scope (e.g. Hagedoorn und Duysters (2002a); Ornaghi (2009)). The respective results confirm the expected alleviation that these similarities have on the integration process. For the same reason unrelated or diversifying transactions have a detrimental effect on the ex post innovativeness (e.g.

Hitt et al. (1991a; Hitt et al. (1991b); Hitt et al. (1996); Ahuja und Katila (2001); Prabhu et al. (2005); Paruchuri et al. (2006); Puranam et al. (2006)).

Concerning the economic situation of the acquirer, the negative relationship between the **financial performance** of the acquirer (as measured by liquidity and accounting performance) and the post merger innovativeness (e.g. Hall et al. (1990); Hitt et al. (1991a; Hitt et al. (1991b)) supports the free cash-flow hypotheses according to which the management prefers to invest free cash-flow in merger & acquisition endeavours rather than distribute it to the shareholders (Jensen (1986); Bruner (1988); Gibbs (1993)). Thus, the underlying motive is the expansion of power and prestige on behalf of the management and the prevention of their personal dismissal or a hostile takeover of their firm (Williamson (1963); Roll (1986); Morck et al. (1990)). According to the 'empire building-hypothesis' these aims are best met by fast growth, which in turn can be achieved through mergers & acquisitions (Baumol (1959); Marris (1964); Mueller (1989); Trautwein (1990)). The picture looks somewhat different if the mergers & acquisitions have to be financed by long term debt. Here the results show that the **debt ratio** is associated with cutbacks in R&D expenditures (innovation input) but stimulates the respective output. Thus, there is an overall positive effect of leverage on R&D efficiency. This can be explained by two interconnected effects: First there is the disciplinary effect of leverage whereby the interest payments and amortisation of the long-term debt goes at the expense of current investments such as R&D (Hall et al. (1990); Miller (1990); Hall (1994)). Second, a high or growing debt ratio also increases the pressure to realize quick results and, thus, causes a shift in the research focus away from long term projects and towards projects that promise quick results (Hall et al. (1990); O'Brien (2003); Marginson und McAulay (2008); Valentini (2011)). Whether this short-termism is merely the picking of low hanging fruits, however, remains to be tested.

As concerns the question of whether or not to **integrate** the target into the acquirer the results do not provide a clear answer. While some studies find a positive impact of integrating the target (Puranam et al. (2006); Kapoor und Lim (2007)), others find the opposite relationship (Puranam et al. (2003); Grimpe (2007); Puranam und Srikanth (2007)). There is only some evidence that preserving the **autonomy** of the target stimulates its post acquisitions innovation output (Grimpe (2007)). The results concerning the centralization of R&D are somewhat clearer. Here, the overall negative effect of decentralization indicates the advantageousness of a more centralized solution (Gerpott (1995); Chakrabarti et al. (1994); Grimpe (2007)).

With respect to the **integration management** we find that while the implementation of intra-organisational visits and meetings has a positive effect on the innovation output (e.g. Bresman et al. (1999)), a policy of communication and information sharing on behalf of the management seems to be associated with a decrease of innovation inputs (Chakrabarti et al. (1994); Gerpott (1995)) while positively affecting the corresponding output (Bresman et al. (1999)). This somewhat counterintuitive result could be a case of reverse causality: instead of the communication and information sharing causing the decrease in R&D expenditures, the ex post cutbacks in R&D, as a result of synergies in terms of redundancies or economies of scale and scope, necessitate the implementation of internal communication and information sharing mechanisms.

Considering the **geographic reach** of mergers & acquisitions, there is some evidence that international transactions contribute more positively to the innovativeness of the acquirer (e.g. Hagedoorn und Duysters (2002a); Cassiman et al. (2005); Prabhu et al. (2005); Cloodt et al. (2006)), than domestic transactions (e.g. Cassiman et al. (2005)). This could indicate that the needed technological resources often reside in firms outside the acquirer's country. European firms seeking to improve their technological standing seek a partnership with technologically advanced targets, independent of their geographic location. The geographic and cultural distance does not seem to impede the absorption of the respective resources - unlike the differences with regard to the **R&D culture** of the partners. Although only two studies investigated the impact of differences in the R&D culture, both come to the conclusion that the existence of such differences impede the innovativeness in terms of both innovation input (Chakrabarti et al. (1994)) and innovation output (Ernst und Vitt (2000)).

The Overall Effect of Mergers & Acquisitions on Innovativeness

Looking at the overall impact of mergers & acquisitions on innovativeness leads to a rather mixed picture. While the studies finding an overall negative impact (25%) outweigh those having found unconditional positive impacts (17%), the majority of the studies (58%) find a conditional or neutral impact of mergers & acquisitions on innovativeness (see Table 3). This confirms that the technological impact of mergers & acquisitions depends to a large extent on the conditional factors analysed above. Table 3 shows the percentage of studies that find an overall positive, neutral or negative impact of mergers & acquisitions on innovation and relates these outcomes to the dependent variable employed by the respective studies.

Table 3: Overall Effect of Mergers & Acquisitions on Innovation Input, Invention Output, and Innovation Output.

Overall Effect	% of all Studies	% of Studies Including the Respective Dependent Variable
positive	17%	50% Innovation Input 0% Inventions Output 50% Innovations Output
conditional / neutral	58%	33% Innovation Input 48% Inventions Output 19% Innovations Output
negative	25%	44% Innovation Input 44% Inventions Output 12% Innovations Output

Considering that the failure rate of mergers & acquisitions is said to vary between 30% and 75% (Souder und Chakrabarti (1984); Bruner (2002); Jensen (2002); Bruner (2004)), the finding that 75% of the studies analysed here allow for a potential positive innovation impact is rather surprising. This indicates that the majority of studies assessing the success of mergers & acquisitions focus on the short-term financial performance only, while neglecting the technological and long-term perspective (see e.g. King et al. (2004)). The results also suggest that the technological impact of mergers & acquisitions is distinctly more positive than the purely financial one, at least if the mediating factors identified above are accounted for.

Furthermore, the results indicate a noticeable difference in the effect that mergers & acquisitions have on the respective dependent variables used to measure innovativeness. For example, among those studies finding an overall positive innovation impact, 50% use innovation input (i.e. R&D expenditures) and innovation output (e.g. newly introduced products) to measure innovativeness. By contrast, close to 50% of those studies finding a conditional or non-significant effect of mergers & acquisitions on the ex post innovativeness use invention output data (i.e. patent activity). In the group of studies indicating an overall negative innovation impact of mergers & acquisitions, both those using innovation input data and those using invention output data account for 44%, while the share of studies employing innovation output data amounts to only 12%.

Due to the differing group size of studies finding a positive, conditional and negative impact on innovativeness, however, it is not directly apparent how the different innovation indicators are affected. Instead, the assessment of the overall impact of mergers & acquisitions on the various dependent variables requires a restructuring of the relevant information (see Table 4). From this it becomes apparent that the highest share of studies suggesting a positive innovation impact of mergers & acquisitions is found among those using the innovation output (e.g. newly introduced products) as dependent variable (29%), followed by those using the innovation input (i.e. R&D expenditures) (21%). By far the lowest share of an overall positive impact is found in the studies using the invention output (i.e. patent activity) as innovation indicator.

Table 4: Distribution of the Overall Impact According to the Dependent Variable.

Dependent Variable	% of all Studies	% of Studies Finding the Respective Overall Impact
Innovation Input	39%	21% positive 50% conditional / neutral 29% negative
Invention Output	42%	6% positive 67% conditional / neutral 27% negative
Innovation Output	19%	29% positive 57% conditional / neutral 14% negative

Summary

In today's high-technology industries, success in tapping external knowledge sources constitutes a central determinant of the learning and innovation capacity of firms (Grant (1996a)). However, while there exists a large body of literature on the financial impact of mergers & acquisitions (e.g. King et al. (2004)), the technological aspect of such transactions were rather neglected for a long time. This, however, has changed in recent years. With technological knowledge being a central determinant of competitiveness, the technological aspects of mergers & acquisitions are increasingly the focus of respective research. The analysis in this paper takes stock of what we know about the overall technological impact of mergers & acquisitions as well as its determinants.

Conducting an intuitive meta-analysis like the one presented here comprises several challenges. First, it relies on second hand data that cannot be scrutinized. We tried to mitigate this problem by including only studies of a high quality standard, i.e. studies published in an academic journal after a blind review process. Second, the variables, although sometimes operationalized differently, have to be aggregated to a certain degree in order to allow for an analysis of their overall impact. Hall (1987) and Hall et al. (1990), for example, approximated the R&D intensity on the industry and not firm level, as do most of the other studies. To minimize the distortion associated with such aggregations, we left our categories as fine grained as possible. This low level of aggregation, however, comes at a price. Due to this comparatively low level of aggregation and the still relatively small sample of studies included in this analysis, we had to abstain from employing statistical tools of meta-analysis such as those presented by Hunter et al. (1982; Hunter und Schmidt (1994, (2004). Instead we followed a more intuitive approach in the analysis and presentation of the outcomes.

This intuitive procedure allowed us to include a neutral category for cases in which the overall impact of mergers & acquisitions was found to be either non-significant or conditional on certain explanatory factors. The identification and analysis of these explanatory factors is the main goal of this paper.

Probably the most critical factor in a literature meta-analysis like the one presented here is the sensitivity of the results to the sample size. Including or excluding only a few studies can lead to significant changes in the respective results. This is due to the small number of observations that we have concerning the impact of the individual variables. Many of these variables are only analysed in two or three studies, which means that the inclusion or exclusion of just one study could result in a very different overall trend concerning the impact of the respective variables. Thus, the larger the sample of studies is, the more reliable the respective results will be. To minimize this distortion we tried to include all relevant studies that meet the selection criteria. To our knowledge the meta-analysis at hand is the most extensive and complete analysis of the empirical literature on the relationship between mergers & acquisition and innovativeness.

Finally it should be noted that the analysis and categorisation of variables, impacts and results always leaves room for interpretation by the original author as well as the researcher performing the meta-analysis. Armour und Teece (1980), for example, find a negative effect of the breadth of the knowledge base on both development expenditures and applied research expenditures but a positive impact on basic research. In a similar way the relative firm size affects the different dependent variables (i.e. the technology transfer, the fluctuation of key inventors, or the innovation input and output) differently.

Whether to classify this result as positive or negative depends on the weighting of these dependent variables. Therefore the insights derived from such an analysis have to be understood as trends and tendencies rather than definite results. However, the purpose of this meta-analysis is not to provide definite answers concerning the determinants of the technological success of mergers & acquisitions, but to take stock of the state of the art. Despite these challenges we are thus confident that our meta-analysis contributes to the research on the technological impact of mergers & acquisitions in several ways. The few existing literature reviews on this topic mostly confine themselves to a short summary and the presentation of the central hypothesis and research questions along with some rather coarse information about the variables investigated (Cassiman et al. (2005); De Man und Duysters (2005)). Thus, the meta-analysis at hand is the first in-depth analysis of the effects that the individual determinants have on post-merger innovativeness. To our knowledge it is also the first meta-analysis that differentiates between the impact of mergers & acquisitions on the innovation input (R&D expenditure), the invention output (patent based indicators) and the innovation output (the introduction of new products).

The results show that the technological impact of mergers & acquisitions is not unconditionally positive or negative, but instead depends on the characteristics of the partnering firms. Among those determinants, the knowledge characteristics (i.e. the categories ‘Knowledge-base’, ‘R&D characteristics’, and ‘product and patent portfolio’) seem to play the most important role. Other important factors are the motive of the transaction, the firm size as well as the market relatedness and the centralization of R&D. Thus, from a technological perspective, the best results can be expected from technologically motivated acquisitions of relatively small international targets with rather specialised expertise in related technological fields and markets.

If we assume that innovation is a prerequisite for a sustained competitive advantage in most industries, these results have important implications for practitioners, political decision makers and researchers alike. Probably the most important implication is that due to the potentially positive impact that mergers & acquisitions can have on a firms' innovativeness, the technology focus should always play an important role in all merger decisions and at all stages of the transaction – from the identification of potential targets to the ex post evaluation of the deal. This could, for example, be achieved by making strategic patent analysis an inherent part of the acquisition and integration process.

From a political and economic perspective, mergers & acquisitions should not exclusively be perceived as reducing the intensity of competition and social welfare, but rather as a means of knowledge transfer and the reallocation of resources to more

productive ends. In some fast growing, high-tech industries, such as pharmaceuticals and biotech, mergers & acquisitions constitute an integral part of the industry dynamics. They provide an exit strategy for entrepreneurial biotech-start-ups and an important source of technological knowledge for the incumbent pharmaceutical firms. In this way mergers & acquisitions provide the necessary incentives for further entrepreneurship and help to transform new technological knowledge into marketable products and services.

Appendix

Annex 1: Impact on Innovation Input.

Categories of Independent Variables	Independent Variables	Number of Studies Including this Variable = 100%	positive	neutral	negative	% positive minus % negative
M&A	M&A	9	22%	33%	44%	**-22%**
Motive	Technological Motive	2	100%	0%	0%	**100%**
	Non-technological Motive	1	0%	100%	0%	**0%**
Knowledge Base	Absolute Size of Knowledge Base	0	0%	0%	0%	**0%**
	Relative Size of Acquired Knowledge Base	0	0%	0%	0%	**0%**
	Breadth of Knowledge Base	1	0%	0%	100%	**-100%**
	Depth of Knowledge Base	0	0%	0%	0%	**0%**
	Concentration of Knowledge Base	0	0%	0%	0%	**0%**
	Quality of Acquired Knowledge Base	0	0%	0%	0%	**0%**
	Technological Relatedness	3	33%	33%	33%	**0%**
	Technological Relatedness^2	0	0%	0%	0%	**0%**
	Technological Complementarity	0	0%	0%	0%	**0%**
R&D Characteristics	Type of Knowledge (codified)	0	0%	0%	0%	**0%**
	Uncertainty	1	0%	0%	100%	**-100%**
	R&D Expenditures or Intensity (Acquirer)	2	100%	0%	0%	**100%**

Continuation of **Annex 1**.

Categories of Independent Variables	Independent Variables	Number of Studies Including this Variable = 100%	positive	neutral	negative	% positive minus % negative
Product and Patent Portfolio	R&D Expenditures or Intensity (Target)	2	100%	0%	0%	**100%**
	Prior Products or Patents (Acquirer)	0	0%	0%	0%	**0%**
	Prior Products or Patents (Target)	0	0%	0%	0%	**0%**
	Desperation Index (High Percentage of Expiring Patents and Old Products)	0	0%	0%	0%	**0%**
Firm Age & Firm Size	Firm Age (Acquirer)	1	100%	0%	0%	**100%**
	Firm Age (Target)	0	0%	0%	0%	**0%**
	Absolute Firm Size Acquirer	6	50%	17%	33%	**17%**
	Absolute Firm Size Target	1	0%	100%	0%	**0%**
	Relative Firm Size (Target / Acquirer)	2	50%	50%	0%	**50%**
	Similarity in Firm Size (Acquirer / Target)	0	0%	0%	0%	**0%**
M&A-Experience	M&A Experience	3	0%	33%	67%	**-67%**
Prior Relations	Prior Relations	1	0%	100%	0%	**0%**
Market Relatedness & Diversification	Market Relatedness	5	20%	60%	20%	**0%**
	Diversification / Conglomerate M&A	2	0%	50%	50%	**-50%**

Continuation of **Annex 1**.

Categories of Independent Variables	Independent Variables	Number of Studies Including this Variable = 100%	positive	neutral	negative	% positive minus % negative
Financial Firm Characteristics	Tobin's Q (Market Value/Book Value)	1	100%	0%	0%	**100%**
	Liquidity	1	0%	100%	0%	**0%**
	Accounting Performance (ROI etc.)	4	0%	50%	50%	**-50%**
	Leverage, Dept Ratio	3	0%	67%	33%	**-33%**
	Leverage Growth / Unprofitability	3	0%	33%	67%	**-67%**
Integration & Organisation	(Degree of) Integration	0	0%	0%	0%	**0%**
	Autonomy of Target	0	0%	0%	0%	**0%**
	R&D Decentralisation	2	0%	50%	50%	**-50%**
	R&D Centralization	1	100%	0%	0%	**100%**
Integration Management	Intra-organisational Visits and Meetings	1	0%	100%	0%	**0%**
	Communication & Information Sharing	2	0%	0%	100%	**-100%**
Geographic & Cultural & Institutional Distance	Difference in R&D Culture	1	0%	0%	100%	**-100%**
	International M&A	5	20%	60%	20%	**0%**
	Domestic M&A	2	0%	50%	50%	**-50%**

Annex 2: Impact on Innovation Output.

Categories of Independent Variables	Independent Variables	Number of Studies Including this Variable = 100%	positive	neutral	negative	% positive minus % negative
M&A	M&A	8	25%	25%	50%	**-25%**
Motive	Technological Motive	2	100%	0%	0%	**100%**
	Non-technological Motive	2	0%	50%	50%	**-50%**
Knowledge Base	Absolute Size of Knowledge Base	3	33%	33%	33%	**0%**
	Relative Size of Acquired Knowledge Base	2	0%	0%	100%	**-100%**
	Breadth of Knowledge Base	1	0%	100%	0%	**0%**
	Depth of Knowledge Base	1	100%	0%	0%	**100%**
	Concentration of Knowledge Base	1	100%	0%	0%	**100%**
	Quality of Acquired Knowledge Base	1	100%	0%	0%	**100%**
	Technological Relatedness	13	62%	31%	8%	**54%**
	Technological Relatedness^2	4	0%	0%	100%	**-100%**
	Technological Complementarity	2	0%	50%	50%	**-50%**
R&D Characteristics	Type of Knowledge (codified)	1	0%	0%	100%	**-100%**
	Uncertainty	1	0%	100%	0%	**0%**
	R&D Expenditures or Intensity (Acquirer)	9	22%	67%	11%	**11%**

Continuation of **Annex 2**

Categories of Independent Variables	Independent Variables	Number of Studies Including this Variable = 100%	positive	neutral	negative	% positive minus % negative
Product and Patent Portfolio	R&D Expenditures or Intensity (Target)	1	100%	0%	0%	**100%**
	Prior Products or Patents (Acquirer)	3	100%	0%	0%	**100%**
	Prior Products or Patents (Target)	5	60%	20%	20%	**40%**
	Desperation Index (High Percentage of Expiring Patents and Old Products	1	100%	0%	0%	**100%**
Firm Age & Firm Size	Firm Age (Acquirer)	1	0%	0%	100%	**-100%**
	Firm Age (Target)	3	33%	0%	67%	**-33%**
	Absolute Firm Size Acquirer	8	63%	25%	13%	**50%**
	Absolute Firm Size Target	5	0%	60%	40%	**-40%**
	Relative Firm Size (Target / Acquirer)	3	33%	33%	33%	**0%**
	Similarity in Firm Size (Acquirer / Target)	1	0%	0%	100%	**-100%**
M&A-Experience	M&A Experience	6	17%	67%	17%	**0%**
Prior Relations	Prior Relations	3	33%	33%	33%	**0%**
Market Relatedness & Diversification	Market Relatedness	9	44%	22%	33%	**11%**
	Diversification / Conglomerate M&A	6	17%	0%	83%	**-67%**

Continuation of **Annex 2**

Categories of Independent Variables	Independent Variables	Number of Studies Including this Variable = 100%	positive	neutral	negative	% positive minus % negative
Financial Firm Characteristics	Tobin's Q (Market Value/Book Value)	1	0%	100%	0%	**0%**
	Liquidity	1	0%	0%	100%	**-100%**
	Accounting Performance (ROI etc.)	3	0%	67%	33%	**-33%**
	Leverage, Dept Ratio	3	33%	33%	33%	**0%**
	Leverage Growth / Unprofitability	1	100%	0%	0%	**100%**
Integration & Organisation	(Degree of) Integration	6	50%	0%	50%	**0%**
	Autonomy of Target	1	100%	0%	0%	**100%**
	R&D Decentralisation	1	0%	100%	0%	**0%**
	R&D Centralization	0	0%	0%	0%	**0%**
Integration Management	Intra-organisational Visits and Meetings	2	50%	50%	0%	**50%**
	Communication & Information Sharing	1	100%	0%	0%	**100%**
Geographic & Cultural & Institutional Distance	Difference in R&D Culture	1	0%	0%	100%	**-100%**
	International M&A	6	50%	50%	0%	**50%**
	Domestic M&A	1	0%	100%	0%	**0%**

Annex 3: Overall Impact on Innovation.

Categories of Independent Variables	Independent Variables	Number of Studies Including this Variable = 100%	positive	neutral	negative	% positive minus % negative
M&A	M&A	17	24%	29%	47%	**-24%**
Motive	Technological Motive	4	100%	0%	0%	**100%**
	Non-technological Motive	3	0%	67%	33%	**-33%**
Knowledge Base	Absolute Size of Knowledge Base	3	33%	33%	33%	**0%**
	Relative Size of Acquired Knowledge Base	2	0%	0%	100%	**-100%**
	Breadth of Knowledge Base	2	0%	50%	50%	**-50%**
	Depth of Knowledge Base	1	100%	0%	0%	**100%**
	Concentration of Knowledge Base	1	100%	0%	0%	**100%**
	Quality of Acquired Knowledge Base	1	100%	0%	0%	**100%**
	Technological Relatedness	16	56%	31%	13%	**44%**
	Technological Relatedness^2	4	0%	0%	100%	**-100%**
	Technological Complementarity	2	0%	50%	50%	**-50%**
R&D Characteristics	Type of Knowledge (codified)	1	0%	0%	100%	**-100%**
	Uncertainty	2	0%	50%	50%	**-50%**
	R&D Expenditures or Intensity (Acquirer)	11	36%	55%	9%	**27%**

Continuation of **Annex 3**

Categories of Independent Variables	Independent Variables	Number of Studies Including this Variable = 100%	positive	neutral	negative	% positive minus % negative
Product and Patent Portfolio	R&D Expenditures or Intensity (Target)	3	100%	0%	0%	**100%**
	Prior Products or Patents (Acquirer)	3	100%	0%	0%	**100%**
	Prior Products or Patents (Target)	5	60%	20%	20%	**40%**
	Desperation Index (High Percentage of Expiring Patents and Old Products	1	100%	0%	0%	**100%**
Firm Age & Firm Size	Firm Age (Acquirer)	2	50%	0%	50%	**0%**
	Firm Age (Target)	3	33%	0%	67%	**-33%**
	Absolute Firm Size Acquirer	14	57%	21%	21%	**36%**
	Absolute Firm Size Target	6	0%	67%	33%	**-33%**
	Relative Firm Size (Target / Acquirer)	5	40%	40%	20%	**20%**
	Similarity in Firm Size (Acquirer / Target)	1	0%	0%	100%	**-100%**
M&A-Experience	M&A Experience	9	11%	56%	33%	**-22%**
Prior Relations	Prior Relations	4	25%	50%	25%	**0%**
Market Relatedness & Diversification	Market Relatedness	14	36%	36%	29%	**7%**
	Diversification / Conglomerate M&A	8	13%	13%	75%	**-63%**

Continuation of **Annex 3**

Categories of Independent Variables	Independent Variables	Number of Studies Including this Variable = 100%	positive	neutral	negative	% positive minus % negative
Financial Firm Characteristics	Tobin's Q (Market Value/Book Value)	2	50%	50%	0%	**50%**
	Liquidity	2	0%	50%	50%	**-50%**
	Accounting Performance (ROI etc.)	7	0%	57%	43%	**-43%**
	Leverage, Dept Ratio	6	17%	50%	33%	**-17%**
	Leverage Growth / Unprofitability	4	25%	25%	50%	**-25%**
Integration & Organisation	(Degree of) Integration	6	50%	0%	50%	**0%**
	Autonomy of Target	1	100%	0%	0%	**100%**
	R&D Decentralisation	3	0%	67%	33%	**-33%**
	R&D Centralization	1	100%	0%	0%	**100%**
Integration Management	Intra-organisational Visits and Meetings	3	33%	67%	0%	**33%**
	Communication & Information Sharing	3	33%	0%	67%	**-33%**
Geographic & Cultural & Institutional Distance	Difference in R&D Culture	2	0%	0%	100%	**-100%**
	International M&A	11	36%	55%	9%	**27%**
	Domestic M&A	3	0%	67%	33%	**-33%**

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