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THE IMPACT OF INTANGIBLE ASSETS ON SHAREHOLDER VALUE IN MERGERS AND ACQUISITIONS

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Abstract

I study how intangible assets influence the acquirer's shareholder value in M&A transactions. Using an event study and a cross-sectional regression analysis, I analyze the impact of patents, R&D expenditures, and other intangible resources on cumulative abnormal returns after M&A announcements. Based on US transactions, I show that intangible assets, particularly patents, positively affect market reactions, while ongoing R&D projects are valued conservatively. Overall, these findings have implications for how disclosure of the target's patents, historical costs, and ongoing research projects can be used from the acquirer's perspective.

Keywords

Intangible Assets, Intellectual Property, Shareholder Value, Mergers and Acquisitions (M&A), Innovation in M&A, Valuation of non-financial metrics

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In today's modern globalized economy, intangible assets are becoming increasingly important (Falato et al. 2022). Due to their non-physical nature, many of these assets are not reflected in the book values of companies and are difficult for investors to measure. For example, the value of consulting firms or business schools is largely based on the expertise and experience of their employees. Human capital serves as an important intangible driver of innovation, growth, and shareholder value, making the acquisition of such capabilities crucial for long-term success, especially in mergers and acquisitions (M&A) (Masulis, Reza, and Guo 2023). While human capital is an important intangible asset, other non-physical resources such as patents, brands, and technical know-how also make up a significant part of a company's value (Simon and Sullivan 1993; R. Hall 1992). These assets provide strategic growth opportunities that not only enable companies to differentiate themselves from their competitors but also create synergies and secure sustainable competitive advantages (Peng, Zhang, and Chang 2021; Arikan 2002; Spender and Grant 1996). The acquisition of intangible assets through M&A allows companies direct access to important resources and strengthens their corporate competencies (Meyer, Mudambi, and Narula 2011). Companies that do not want to invest in expensive and time-consuming Research and Development (R&D) often use takeovers to acquire innovative solutions quickly. The acquired resources and technologies enable them to significantly increase the value of the company (Phillips and Zhdanov 2013).

Despite the growing importance of intangible assets in M&A transactions, there is still a limited understanding of how these assets are valued and how they affect the market value of a company. Transaction parties (i.e., acquirers, sellers, and targets) as well as shareholders face difficulties in assessing the correct value and impact of intangible assets (Moro-Visconti 2022). Addressing these challenges, I examine how intangible assets affect market valuations in M&A. In analyzing the private economic value of patents, which grant a 20-year exclusive right to a new invention that "excludes others from making, using, offering for sale, or selling" and

represents knowledge gained from successful investments (United States Patents and Trademark Office 2024), I also include historical corporate investments that reflect industry-specific variations in the costs and benefits of intangible assets. Using an event study methodology combined with cross-sectional regression analysis, I examine how intangible assets influence immediate market reactions to M&A announcements, focusing on domestic US transactions from 2000 to 2022. In this approach, I consider the impact of intangible assets on the acquirer's market value to reflect the shareholders' perspective. However, I do not focus on the impact on transaction value in this study as this is negotiable, not yet available at the time of announcement, and does not reflect the impact on shareholder value.

The relevance of this research is twofold: from a theoretical position, it provides insights that improve the understanding of the role of intangible assets in M&A, as the M&A market is one of the largest in the world with a cumulative transaction value of USD 2.4 trillion in 2023 (Bain & Company, n.d.). From a practical perspective, it provides insights for managers and investors involved in the valuation and strategic development of M&A. This work can help to clarify the complex interplay between M&A, intangible assets, and shareholder value, thus providing a potential basis for decision-making in future transactions.

The empirical results of this study are consistent with the methodology applied and show that both the matched economic value of patents and the intensity of the intangible property have a significant positive impact on the cumulative abnormal returns (CAR). Analyzing patents using a similarity score between acquirer and target shows that at very high market valuations (in the range of USD billions) per unit, there can be a considerable contribution to increasing the acquirer's market capitalization in the announcement window. The intensity of the adjusted intangible resources also has a positive effect, but this effect is only small in relation to the actual deal value and has a limited impact on shareholder value. Moreover, ongoing R&D projects tend to be valued conservatively by the market in the study and have a negative effect on

shareholder value. Robustness tests confirm these results and indicate that both alternative estimation models and different data sources for intangible assets lead to comparable results.

Previous studies show that intangible assets have various effects on corporate performance in the context of M&A. Arikan (2002) suggests that market reactions to acquisitions of highly intangible targets may fluctuate due to overconfidence of the acquirer or unexpected integration challenges. Sevilir and Tian (2012) find that acquiring innovative targets leads to higher abnormal returns, especially when the targets' innovativeness exceeds that of the acquirers. Clausen and Hirth (2016) emphasize the role of intangible assets in explaining acquisition prices, with changes in market capitalization positively correlated with R&D spending and earnings-based measures of intangibility. Building on this work, Masulis, Reza, and Guo (2023) show that acquisitions of intangible targets generate higher announcement returns due to synergies and growth opportunities, especially when acquirers have financial or informational advantages. Through this study, I aim to extend this research by analyzing the impact of intangible assets on market valuation in M&A, including real patent values, historical investments, and current research projects. In doing so, I provide new insights into the different effects of different types of intangible assets.

The remaining sections of the thesis are structured as follows: Chapter I covers the theoretical foundations and provides a comprehensive literature review. Chapter II presents the data using descriptive statistics, outlines the structure of the empirical analysis, and explains the most important determinants to be examined. Chapter III presents the results of the empirical study, while Chapter IV discusses these results in the context of the existing literature and their practical implications. Finally, Chapter V summarizes the most important results.

I. Theory and literature review

A. Strategic and financial impact of intangible assets

Intangible assets are non-physical assets that can provide future economic benefits to a

company according to IAS 38 (IASB 2020, para. 8) and include, i. a., intellectual property (IP), such as patents, trademarks, copyrights, and confidential databases (WIPO 2020). IP is a legally protected form of intangible asset and grants its owner exclusive rights to it (WIPO 2020). However, intangible assets also include non-IP assets, such as trade secrets, publicity rights, and domain names, which may not always have formal legal protections but still add significant value to a business (American Association of University Professors, n.d.). According to the literature, an increasing proportion of intangible assets are not recognized in the balance sheet today, as shown in Appendix 1, (Lim, Macias, and Moeller 2020; Corona 2009) and intellectual capital is insufficiently captured by financial reporting (Fischer and Baumgartner 2021). Compared to tangible assets, they are more difficult to recognize because, for example, they often have no resale value, which makes their valuation complex (Stein 1989). The non-activated capabilities describe, among other things, the expertise of employees, suppliers, and consultants, the corporate culture, and the network of a company (R. Hall 1992). In addition, intangible assets act as strategic factors of production, making it difficult for other players to enter the market and helping companies to realize exceptional returns (Arikan 2002; Lindenberg and Ross 1981). The literature identifies many dimensions of intellectual capital, which will not be discussed in detail here, but an overview is provided in Appendix 2.

Companies can gain sustainable competitive advantage from intangible assets by supporting strategies that are difficult for current and potential competitors to replicate (Battagello, Cricelli, and Grimaldi 2019; Barney 1991). Moreover, these assets influence a firm's success through the emotional responses of customers, employees, clients, and investors, as evidenced by Warren (2000). Numerous studies highlight their positive influence as growth and value drivers, which is primarily due to the expertise of employees and the activities of R&D and, among other things, leads to higher market capitalizations (Tahat, Ahmed, and Alhadab 2018; Whitwell, Lukas, and Hill 2007; R. Hall 1992; Sorrentino et al. 2024; Heiens, Leach, and

Mcgrath 2007; Simon and Sullivan 1993).

In addition, companies are particularly interested in how their shareholders value intangible assets, as these account for an ever-increasing proportion of a company's capital stock in the digital age (Crouzet and Eberly 2019; Cosmulese et al. 2021; Heiens, Leach, and Mcgrath 2007). While the literature shows that a higher intangible intensity of the company generally has a positive influence on the company valuation (Clausen and Hirth 2016; Yamaguchi 2014), the results concerning R&D expenditure are mixed. Whitwell, Lukas, and Hill (2007) show that R&D expenses have a positive influence on the financial market performance of a company, whereas Heiens, Leach, and Mcgrath (2007) document an increased risk with excessively high R&D expenses. Notably, companies with a higher intangible intensity, not fully captured by the balance sheet as described, tend to have a higher Tobin's Q value due to a higher market value (Moura et al. 2020). In M&A transactions, a high Tobin's Q value can signal to the acquirer potential synergies and growth opportunities through the acquisition of intangible assets like patents, brand values, or R&D capacities. In contrast to the acquisition costs, Tobin's Q reflects the replacement costs. Furthermore, it should be noted that intangible assets are subject to a certain degree of loss in each period, as their patented technologies, for example, become obsolete (Corona 2009).

B. Intangible assets in M&A as strategic drivers of growth and innovation

M&A transactions are strategic channels used by companies to increase their market share, enhance their "core competencies" and raise more capital through low capital costs (Kongpichayanond 2009). Collaborative production and research facilities allow companies to achieve economies of scale and scope (Masulis, Reza, and Guo 2023), as well as access to new intangible assets and rapid access to capabilities (Sorrentino et al. 2024; Meyer, Mudambi, and Narula 2011). The acquisition of marketing-related, technology-based, and customer-related intangible assets aims to generate synergy effects (Masulis, Reza, and Guo 2023). Additionally,

M&A allows acquirers to expand their investment opportunities by buying companies that are experiencing financial difficulties (Masulis, Reza, and Guo 2023) and, in the process, to adopt innovations without being exposed to the risk of failed R&D investments (Phillips and Zhdanov 2013; Heiens, Leach, and Mcgrath 2007). Bena and Li (2014) show that companies with low R&D spending and large portfolios tend to favor acquisitions. In practice, larger companies in R&D-intensive industries often face lower capital costs (B. Hall 2002). Targets that have a high cost of capital and are consequently financially constrained, as well as the undervaluation of intangible assets by the target as they are unable to realize the benefits in the pre-merger stage, leads to lower takeover prices. (Masulis, Reza, and Guo 2023).

The ability to carry out acquisitions depends on several factors, such as the type of transaction (asset vs. share deals) and the timing (e.g. transaction year) (Sorrentino et al. 2024). Effective strategic management that aligns long-term corporate goals with potential intangible benefits (Keller 2001), as well as a differentiated valuation of target firms by the acquirers into intangible and tangible assets, is essential (Lehmann and Schwerdtfeger 2016). Valuing the intangible assets of listed companies (the focus of the project) is a complex process for investors (Sacui and Szatmary 2015). Although investors generally take intangible assets into account when evaluating companies (R. E. Hall 2001), their influence and magnitude largely depend on whether the acquired intangible resources can be successfully used after the acquisition (Lehmann and Schwerdtfeger 2016).

II. Research Methodology

A. Data sample and descriptive statistics

The dataset used for this study is based on SDC Platinum M&A announcements from 1/1/2000 to 12/31/2022 and is selected for two reasons: First, patent value data is only available until 2022, and second, since the beginning of this century, intangibles have become more important in company valuation (see Appendices 3 and 4). The deal selection process is based on the

following criteria and is generally in line with other authors (Masulis, Reza, and Guo 2023; Bhattacharya and Li 2020): (i) The acquirer may not hold more than 50% of the target company's shares before the announcement and must own 100% after the transaction is completed. Full ownership not only grants the acquirer sole control over all corporate decisions but also eliminates potential conflicts with minority shareholders and allows for a smoother integration and restructuring of the target company. Prior to the transaction, the acquirer does not have full influence over the management, strategic direction, and resources of the target company. (ii) Both target and acquirer must be listed on one of the largest US stock exchanges, namely American Stock Exchange (AMEX), Nasdaq Stock Market (Nasdaq), or New York Stock Exchange (NYSE). (iii) A deal value must be documented. (iv) Financial information must be available in Compustat for both the acquirer and the target. (v) Neither company may be a government entity (Standard Industrial Classification (SIC) codes starting with 9 are excluded). The study does not exclude financial institutions (SIC 60-67), as these also have intangible assets and, in line with Masulis, Reza, and Guo (2023), a comprehensive analysis of the influence of intangible assets also has an impact on acquirer returns in this sector.

The share prices and the number of shares issued, as well as any public financial information, such as total assets, recognized intangible assets, debt, revenue, R&D- and Selling, General, and Administrative (SGA) expenses, have been obtained from the Compustat - Capital IQ database. While the share prices are available for each trading day, the financial information is available quarterly. Past transactions affecting both the acquirer and the industry, in general, were downloaded by SDC Platinum. The data set also contains real and nominal dollar values of patents for listed stock corporations originating from Kogan et al. (2017). While this study is based on “gvkey”, the providers of the datasets have provided “permno” as the identifier. To convert “permno” and “SDC Deal Numbers” to “gvkey” format, data sets from Ewens, Peters,

and Wang (2024) and Ewens and Marx (2024) are used.[1] While SDC Platinum also provides CUSIP identifiers, these are limited to 6-digit codes, while Compustat requires 9-digit CUSIPs, making direct conversion difficult. The primary restriction is the conversion of SDC transaction numbers to "gvkey" for acquirers and targets, as the manually created data set by Ewens, Peters, and Wang (2024) has only a limited overlap where both the acquirer and target "gvkey" are available.

Since this analysis only utilizes financial information from quarterly reports, these figures may not fully capture the actual value involved in the transaction. However, these are the only metrics available to most investors, apart from insiders. Therefore, the values from the most recent available report are used in the analysis as of the announcement date. Missing values that are not mandatory, such as R&D expenses, are assigned a value of 0 in the analysis. Similarly, non-existent patent values are also set to 0. If the target company is not a listed corporation, the data set from Kogan et al. (2017) would not include the private value of the patents, since in this case no market reaction can be recorded. For this reason, as described above, only listed stock corporations are considered in the sample.

The analyzed data set includes a total of 1,142 transactions, as detailed in Table 1. Panel A shows that during the sample period, the number of M&A deals tends to decrease, while the average transaction value increases and reaches its peak in 2020. Both the average market value of acquirers and the average total assets of target companies show a general upward trend throughout the sample period. In addition, the share of intangible assets in transactions increases and peaks in 2021, underlining their growing importance in acquisition strategies. Most acquisitions take place in the manufacturing (SIC: 20-39) and services (SIC: 70-89) sectors, while activity in the agriculture, forestry, and fishing (SIC: 01-09) and construction (SIC: 15-17) sectors remains minimal, as shown in Panel B.

[1] The corresponding data sets can be downloaded here: https://github.com/michaelewens/SDC-to-Compustat-Mapping/blob/master/dealnum_to_gvkey.csv.

Table 1. Overview of M&A Deals used in the sample

Panel A: M&A Deals by Year, along with Acquirer and Target Characteristics

Year	Number of Deals	Average Deal Value (in millions USD)	Acquirer	Target	
			Average Market Value (in millions USD)	Average Total Assets (in millions USD)	Average Intangible Assets Share in Deal
2000	70	554	13,212	5,202	0.00
2001	119	293	5,894	6,503	0.01
2002	102	173	4,867	10,967	0.12
2003	96	302	5,138	3,812	0.17
2004	77	571	5,204	10,153	0.18
2005	80	612	9,511	3,254	0.15
2006	67	569	8,797	13,744	0.17
2007	68	1,132	15,517	19,903	0.19
2008	48	331	16,085	2,926	0.19
2009	54	995	8,298	14,371	0.21
2010	49	846	10,894	18,230	0.22
2011	32	1,310	19,274	6,983	0.21
2012	44	703	13,219	38,681	0.18
2013	33	1,014	10,245	6,402	0.20
2014	48	828	9,241	8,578	0.20
2015	55	2,184	10,378	19,414	0.19
2016	33	1,051	16,998	1,150	0.19
2017	16	1,304	11,909	313	0.25
2018	17	3,177	17,826	2,434	0.16
2019	10	1,808	44,952	573	0.11
2020	12	6,644	24,071	2,361	0.13
2021	8	5,456	59,600	1,915	0.26
2022	4	690	5,899	266	0.18
Total	**1,142**	**840**	**10,526**	**10,070**	**0.14**

Panel B: M&A Deals Distribution by Industry and Year

Division	A	B	C	D	E	F	G	H	I
SIC	01 - 09	10 - 14	15 - 17	20 - 39	40 - 49	50 - 51	52 - 59	60-68	70 - 89
Industry	Agriculture, Forestry, and Fishing	Mining	Construction	Manufacturing	Transportation, Communications, Electric, Gas, and Sanitary service	Wholesale Trade	Retail Trade	Finance, Insurance, And Real Estate	Services
Year									
2000	0	0	0	29	9	0	5	3	24
2001	0	2	0	52	13	3	2	5	42
2002	0	3	0	40	5	4	3	2	45
2003	0	0	0	48	7	0	4	0	37
2004	0	4	0	41	4	0	0	2	26
2005	0	0	0	44	9	2	0	2	23
2006	0	3	0	39	5	0	3	0	17
2007	0	3	0	38	4	0	3	4	16
2008	0	2	0	25	2	0	2	0	17
2009	0	2	0	30	7	0	0	0	15
2010	0	5	0	26	2	3	0	0	13
2011	0	3	0	18	4	0	0	0	7
2012	0	4	0	20	2	3	3	4	8
2013	0	4	0	19	3	0	0	0	7
2014	0	6	0	22	5	2	0	5	8
2015	0	3	0	31	8	0	3	2	8
2016	0	0	0	22	3	2	0	0	6
2017	0	0	0	14	0	0	0	0	2
2018	0	4	0	7	3	0	0	0	3
2019	0	0	0	10	0	0	0	0	0
2020	0	0	0	8	0	0	2	0	2
2021	0	0	0	5	0	0	0	0	3
2022	0	0	0	4	0	0	0	0	0
Total	**0**	**48**	**0**	**592**	**95**	**19**	**30**	**29**	**329**

Source: Own illustration, allocation of SIC based on U.S. Department Of Labor (n.d.).

B. Design of the study

In this research, an event study is conducted in combination with a cross-sectional regression analysis to analyze the market reactions to M&A announcements and to investigate the role of intangible assets in this process. The event study measures the abnormal returns of the acquirer's shares in the context of the takeover announcements (MacKinlay 1997; Brown and Warner 1980; 1985). Expected returns are calculated using the Fama-French 5-Factor (FF5) model with an estimation window of [-130, -10] trading days before the announcement date and are widely accepted in research (MacKinlay 1997). Deals for which no data is available for at least 120 days before the announcement, or which overlap with other deals, are excluded from the analysis. The FF5 model is used to predict the expected return because it incorporates additional systematic risk factors beyond size and value, specifically profitability and investment, thereby improving the model's ability to explain fluctuations in stock returns more accurately than traditional models such as the Capital Asset Pricing Model (CAPM) or Fama-French 3-Factor (FF3) model (Fama and French 2015). The analysis initially considers a three-day event window of [-1, 1] days around the announcement date. Buffering between the estimation window and the event window is intended to reduce information asymmetries that may exist before the announcement so that more stable estimates can be predicted. Abnormal returns result from the difference between the actual return of the acquiring company i on day t and the expected return of the company i on that day t according to the FF5 model. The CAR are calculated as the sum of the abnormal returns of the company i over the entire event window.[2] After calculating the CAR, a cross-sectional regression analysis is performed with the CAR within the respective event window as the dependent variable. Cross-sectional regression analysis, which is widely used in financial research (Fama and French 1993; 2015), is used to identify factors that influence CAR, with the independent variables categorized into four categories:

[2] Similarly, I have also considered the [-2, 2] and [-3, 3] event time windows in the later robustness section.

(i) Target characteristics, (ii) Acquirer characteristics, (iii) Industry characteristics, and (iv) Market characteristics. As already mentioned, the main difficulty with intangible assets is determining their correct value. Due to accounting rules, only a small proportion of these assets are recognized in the balance sheet, leaving important elements such as employee know-how largely unconsidered. In this analysis, I, therefore, attempt to estimate the value of a company's knowledge and intellectual capital and, in line with other authors, divide a company's intangible capital into two areas: knowledge capital and organizational capital (Ewens, Peters, and Wang 2024; Peters and Taylor 2017). Patents serve, as they do in this study, as a proxy for estimating a firm's innovative capacity and can be more precisely categorized as a component of intellectual capital. Kogan et al. (2017) use a method to price the economic value of patents based on market reactions. The underlying assumption is that stock prices provide a forward-looking estimate of the private value of a patent. The calculation is based on a three-day event window starting from the date of the patent grant to isolate the effects of this announcement on stock prices and aligns them with general market movements through idiosyncratic returns:

(1) $$R_j = v_j + \epsilon_j$$

where v_j represents the patent-specific value component and ϵ_j denotes unrelated movements. The economic value of a patent EPV_j is defined as the product of the estimated patent-related return and the firm's market capitalization before the patent grant:

(2) $$EPV_j = \frac{1}{1-\bar{\pi}_j} \times \frac{1}{N_j} \times E[v_j|R_j] \times M_j$$

where N_j is the number of patents granted to a company on the same day as patent j and M_j is the market capitalization of the day before the company's patent j was published. $\bar{\pi}_j$ is the probability of a successful patent application based on historical acceptance rates. The real patent value is adjusted to the prices in the year 1982 by deflating the nominal value with the Consumer Price Index. Using this method, the economic value of patents, already calculated by the authors, is incorporated as a cumulative sum for each target up to the point of the

announcement. This value is then multiplied by the similarity score from Bloom, Schankerman, and van Reenen (2013) and is included in the regression analysis with the variable EPA. The score, which ranges from 0 to 100 percent, measures the technological similarity between acquirer and target based on the distribution of their patents across technology fields. The calculation is based on the cosine similarity formula, a detailed scheme is included in Appendix 5 as this is not the main focus of the paper. Besides successful patent applications, companies have various other intangible assets that contribute to their value. As mentioned above, the current state of intangible assets is limited, and available data is insufficient. Apart from patents and trademarks, which were examined by Desai et al. (2022), little attention is paid to the valuation of other intangible assets before M&A transactions.

For further analysis, a cost approach is used in which a firm's intangible assets are estimated by evaluating R&D spending (knowledge capital) and SGA expenses (organizational capital), which is also used similarly by Peters and Tylor (2017). These values are adjusted based on the depreciation rates of the Bureau of Economic Analysis (2024) and reduced by the total value of the previously calculated patent valuations (see equation (3)) since these are already used in this analysis and may include components such as employee knowledge. In this step, the total value of all patents of the target is deducted, as patents that exist at the target but cannot be used by the acquirer also offer very poor economic value added. Nonetheless, it is still important to take additional R&D spending into account, since even "failed" R&D investments that do not lead to patents can still contribute to valuable knowledge. In this analysis, historical R&D and SGA expenses are cumulated because their importance and magnitude vary across industries. Knowledge capital includes elements such as technical know-how, technological capabilities, and non-patented innovations, while organizational capital includes business processes, management practices, and customer relationships (Peters and Taylor 2017). The depreciation rates δ_{RD} and ρ_{SGA} are based on the average provided by the Bureau of Economic Analysis (2024)

for each category and were manually assigned to the corresponding SIC. Residual values are calculated using these depreciation rates and reflect the progressive depreciation of both R&D and SGA investments over time.

$$(3) \qquad Intangible\ property_i = \sum_{k=1}^{\infty}(1-\delta_{RD})^k \times R\&D_{i,t-k} + \sum_{k=0}^{\infty}(1-\rho_{SGA})^k \times SGA_{i,t-k} - \sum_{j=1}^{m} EPV_{i,j}$$

In the formula, m is used as the total number of patents held by company i, while k indicates the period in years in which historical expenditure is considered. In the analysis, such influence is measured using the variable *Adjusted Intangible Property Intensity*[3], which is scaled based on the transaction value. It should be noted that R&D expenditures are only included in this analysis up to one period ($k = 1$) in advance, as it is assumed that the R&D activities from the interval from the announcement date up to one year in advance are still ongoing and are therefore included in the analysis as a separate determinant.

Ongoing research intensity is defined by the R&D expenditure of the last 12 months in relation to the turnover of the same period and is considered as *Unrealized R&D*. Using this method aims to avoid overlaps in the analysis and enables a more precise assessment of the company's intellectual and organizational capital, which is often not fully reflected in the balance sheet.

In the analysis of acquirer characteristics, the natural logarithm of the acquirer's market capitalization 10 days before the announcement is used as the *Acquirer Size*. As this varies by acquirer, the logarithmic transformation minimizes scaling effects and improves comparability and model fit. The *Leverage Ratio* (debt-to-total-assets ratio) and the cumulative value of M&A transactions of the last 10 years as the *Value of last M&A activities* are also considered as a function of the acquirer at the announcement date. In the industry analysis, the dummy variable *Intensity of M&A market* is assigned based on the Herfindahl-Hirschman Index (HHI)[4], which is calculated using the cumulative 10-year M&A deal value for each industry. Industries within

[3] "Intangible property" is used here to include not only patents, copyrights and trademarks, but also various forms of corporate knowledge. (American Association of University Professors, n.d.).

[4] The HHI measures the market concentration by calculating the sum of the squared market shares of deal values.

the 80th percentile or above in terms of M&A market concentration are assigned a dummy variable indicating high market dominance. Macroeconomic conditions are analyzed with the variable *Market Performance* by examining the average market return over the last 60 trading days, using the S&P 500 index as a benchmark. Based on this, equation (4) is formed, whereby the variables are additionally summarized in Appendix 6.

$$\begin{aligned} CAR_{\mathrm{i}} &= \alpha + \beta_1\, EPA + \beta_2\, Adjusted\ Intangible\ Property\ Intensity + \beta_3\, Unrealized\ R\&D \\ &+ \beta_4\, Acquirer\ Size + \beta_5\, Leverage\ Ratio + \beta_6\, Value\ of\ last\ M\&A\ activities \\ &+ \beta_7\, Intensity\ of\ M\&A\ market + \beta_8\, Market\ Performance + \varepsilon \end{aligned} \tag{4}$$

Within the analysis, standard errors are clustered at the SIC level to account for potential correlations within groups and to allow for robust statistical inference. In addition, fixed effects resulting from the interaction of industry and year are included to control for unobserved heterogeneity both between industries and over time.

III. Results

A. Empirical findings

As part of the analysis, an initial examination is conducted to assess how M&A announcements generally impact share prices within the sample, with the results presented in Table 2. The various event windows show that the CAR in the [-1, 1] window are not statistically different from zero, while the CAR in the [-2, 2] window are significantly greater than zero at the 1% significance level. In the extended [-3, 3] event window, the CAR remain significant at the 5% level. This shows that shareholders in the sample perceive M&A announcements differently depending on their time horizon.

Table 2. Results for CAR Across Different Event Windows using FF5 model

	Event Window		
	[-1, 1]	[-2, 2]	[-3, 3]
CAR	0.0020	0.0038	0.0031
	(1.17)	(2.52)	(2.08)
Observations	3,762	6,260	8,757

Note: The mean value is shown and the t-statistic derived from a one-sample t-test to test whether the mean CAR is significantly different from zero is shown in parentheses.

The study then examines several models that gradually incorporate additional variables to test an increasing number of influencing factors. In model 1 shown in Table 3, only the influence of the target company's *EPA* on the CAR is evaluated. The result is statistically significant at the 1% level and shows a positive coefficient. In model 2, the study introduces the additional variable *Adjusted Intangible Property Intensity* to further analyze the factors influencing the CAR. The coefficient for *EPA* remains positive and statistically significant at the 1% level as well as the coefficient for the *Adjusted Intangible Property Intensity* is positive and statistically significant at the 5% level. In model 3, the additional variable *Unrealized R&D* is considered to include the effects of unfinished R&D projects as a factor of revenue on the CAR. The coefficients for *EPA* and *Adjusted Intangible Property Intensity* remain positive and statistically significant at the same level. However, *Unrealized R&D* has a negative coefficient and is statistically significant at the 1% level. In model 4, additional control variables related to the acquirer, such as size, leverage, and the value of past transactions, are included. The coefficient for *EPA* remains positive and statistically significant at the same significance level, similar to the *Adjusted Intangible Property Intensity* which is now also significant at the 1% level. *Unrealized R&D* continues to have a negative coefficient at the same level of significance. Among the new variables, only the coefficient for the *Value of last M&A activities* is negative and significant at the 5% level. Finally, the additional variables *Intensity of M&A market* in the industry, and *Market Performance* are included in model 5. None of the previously considered coefficients change their coefficients or their statistical significance. *Intensity of M&A market* has no significant influence in the model, whereas the coefficient for *Market Performance* is positive and statistically significant at a 1% level. In sum, all models show similar results.

The economic impact of this study consistently shows a positive effect of *EPA* and *Adjusted Intangible Property Intensity* on CAR, emphasizing the importance of intangible assets for M&A outcomes. In particular, *EPA* with a coefficient of 0.0033 indicates that a one-unit

increase leads to a 0.33% increase in CAR and represents a significant financial effect given the scale of M&A. Similarly, *Adjusted Intangible Property Intensity*, while having a low coefficient, has a measurable positive impact scaled by transaction value, highlighting its subtle and significant role in market reactions. In contrast, *Unrealized R&D* shows a negative and statistically significant effect with a coefficient of -0.0013, suggesting that higher levels of incomplete R&D efforts reduce CAR, reflecting investor caution towards unfinished projects.

Table 3. Results of the cross-sectional regression analysis using the FF5 model

Independent Variable	CAR [-1, 1]				
	(1)	(2)	(3)	(4)	(5)
Intangible characteristics					
EPA	0.0029***	0.0036***	0.0035***	0.0031***	0.0033***
	(76.13)	(17.42)	(16.86)	(18.29)	(17.62)
Adjusted Intangible Property Intensity		0.0000**	0.0000**	0.0000***	0.0000***
		(3.62)	(3.53)	(6.02)	(6.39)
Unrealized R&D			-0.0015***	-0.0014***	-0.0013***
			(-23.8)	(-13.17)	(-14.43)
Acquirer characteristics					
Acquirer Size				-0.0007	-0.0010
				(-0.31)	(-0.48)
Leverage Ratio				0.0041	0.0039
				(0.94)	(0.85)
Value of last M&A activities				-0.0018**	-0.0017**
				(-2.67)	(-2.81)
Industry characteristics					
Intensity of M&A market					-0.0082
					(-0.69)
Market characteristics					
Market Performance					7.9882***
					(3.74)
Sector Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	1142	1142	1142	1116	1116
R^2	0.0674	0.0685	0.0746	0.0912	0.0971

Note: Patent values are included in the analysis in USD billions. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. t-statistics are reported in parentheses.

B. Robustness

To ensure the reliability of the empirical results, various robustness tests are carried out using alternative event windows and modeling approaches. In addition to the FF5, the FF3 and the market model, based on the S&P 500 index, are also considered in the event windows [-1, 1],

[-2, 2], and [-3, 3], while the estimation window remains unchanged (see Table 4 for a summarized overview and Appendices 7 - 14 for the detailed regression results).

Table 4. Summary of robustness for alternative event windows and prediction models

	Coefficient	t-statistics
Panel A: Prediction with FF5 in [-2, 2] event window		
EPA	0.0024	11.98
Adjusted Intangible Property Intensity	0.0000	2.59
Unrealized R&D	-0.0014	-8.19
Panel B: Prediction with FF5 in [-3, 3] event window		
EPA	0.0026	7.81
Adjusted Intangible Property Intensity	0.0000	0.87
Unrealized R&D	-0.0015	-7.74
Panel C: Prediction with FF3 in [-1, 1] event window		
EPA	0.0033	17.62
Adjusted Intangible Property Intensity	0.0000	6.39
Unrealized R&D	-0.0013	-14.43
Panel D: Prediction with market model in [-1, 1] event window		
EPA	0.0033	17.62
Adjusted Intangible Property Intensity	0.0000	6.39
Unrealized R&D	-0.0013	-14.43

Note: Patent values are included in the analysis in USD billions. The models are structured according to the scheme shown in Model 5.

The analysis shows in all estimation models that in the shorter periods, i.e. in the three-day and five-day window, both *EPA* and *Adjusted Intangible Property Intensity* continue to have a significant positive influence on the CAR. At the same time, the negative significant effect of *Unrealized R&D* remains. The extended seven-day window shows that the relevance of *EPA* and *Unrealized R&D* remains largely constant, while the *Adjusted Intangible Property Intensity* remains positive but is no longer significant. These observations suggest that the relevance of *Adjusted intangible property intensity* is more pronounced in shorter event windows, while in longer time windows this effect weakens.

The model is also tested for robustness during bubble years, which according to Haddad, Ho, and Loualiche (2022) represent phases of intense speculation in which industry prices rise sharply and decouple from fundamental values. By doing so, it should be ensured that the results of intangible assets in M&A analyses are not influenced by speculative distortions. Corresponding bubbles are available annually and by SIC (already defined by the authors mentioned) and show that the coefficient for *EPA* remains positive and significant in all time

periods, while *Adjusted Intangible Property Intesity* is only significant in the three- and seven-day windows and *Unrealized R&D* only in the seven-day window (not tabulated).

In addition to the various valuation models used to estimate CAR, it is also valuable to analyze how the acquirer's shareholders perceived the intangible assets, using the financial information from the published transaction reports as a reference. Ewens, Peters, and Wang (2024) provide a dataset based on data reported by acquirers in their 10-K filings regarding intangible assets. However, since the primary focus of this study is to investigate shareholder perceptions and valuations of these intangible assets directly, this dataset was initially not considered and is introduced here only to test robustness. In the 10-K filings, patents are treated as an independent factor, while the adjusted intangibility metric is calculated as the sum of trademarks, trade names, brands, technology, workforce, non-compete agreements, maintenance contracts, customer relationships, and contractual rights. This analysis mainly considers the aggregate of these individual values separately to enhance comparability. In-process R&D is also treated independently, with the natural logarithm applied, as ASC 805 (FASB 2024) does not provide specific information on the exact period of ongoing research activities, thus ensuring better comparability. To include deals in this analysis, SDC deal numbers from this dataset must match those in the overall sample, resulting in a total of 458 overlapping transactions in the period from 2000 to 2017. The results show that in all three event windows [-1, 1], [-2, 2], and [-3, 3] and within all estimation models, the coefficients for *Patents* and *Adjusted Intangible Property* have a positive and statistically significant influence on the CAR, while *In-process R&D* has a negative and statistically significant coefficient (see Table 5).

The analysis of the individual items instead of the cumulative key figure for adjusted intangible property shows that the values for customer relationships and technology in particular have a positive significant influence (results not tabulated), which would, however, presuppose that uniform valuation methods are always used by the various acquirers.

Table 5. Impact of data from 10-K reporting on the CAR using FF5 as a prediction model

	CAR [-1, 1]	CAR [-2, 2]	CAR [-3, 4]
Patents	0.1048***	0.3491***	0.1866***
	(18.09)	(56.09)	(41.97)
Adjusted Intangible	0.0016***	0.0022***	0.0023***
Property	(36.31)	(73.36)	(26.23)
In-process R&D	-0.0079***	-0.0093**	-0.0094**
	(-41.32)	(-3.9)	(-3.56)
Sector Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Observations	458	457	457
R^2	0.1009	0.1372	0.0998

Note: All values are included in the analysis in USD billions. ∗∗∗, ∗∗, and ∗ denote statistical significance at the 1%, 5%, and 10% levels, respectively.

C. Limitations

Since this study only examines US companies, this may limit the transferability of the results and may lead to different responses in non-US markets. Furthermore, the sample may be skewed towards larger companies, since financial data for smaller companies is often insufficiently available and the conversion of SDC deals into company-specific information is largely based on the database created by Ewens, Peters, and Wang (2024), which primarily contains large companies as acquirers. In the dataset used by Kogan et al. (2017), the value of patents was determined based on market reactions, which in turn requires that the target is a listed corporation. Additionally, public limited companies may not be equally represented in all industries, as is the case in this sample (see Table 1). The results could therefore be different for smaller companies that are underrepresented in this sample, which could lead to a potential distortion of the results. Also, the patent value is only considered in a three-day time frame.

Another limitation is the use of quarterly financial data that does not accurately reflect the exact value of the company at the time of the announcement and ignores interim changes in key figures. Although patents are given a similarity score to estimate what proportion can be used by the acquirer, this is only an estimate and not a static value. The valuation of intangible assets, such as employee expertise, is approximated using R&D and SGA spending, which may not represent the actual value of these assets. Similarly, this estimate is highly dependent on the

depreciation rates used, which are different for each company and are used in this analysis in the form of sectors. The acquirer's usage options are only assigned a similarity score for patents. This analysis lacks a detailed breakdown of the specific intangible assets valued by shareholders, highlighting the challenge that these assets can vary significantly across sectors. Furthermore, the event study approach only captures the short-term market reactions, but not the long-term effects. Unexpected events during the study period could also influence the results. The factors and market models used take systematic risks into account but do not directly consider macroeconomic variables such as interest rates or inflation, which could make the analysis of market reactions incomplete.

To sum up, the results can provide valuable insights into the short-term market effects of M&A announcements, as long as they are interpreted in light of the limitations identified.

IV. Discussion

Results from this study provide new insights regarding the role of intangible assets in determining shareholder value in M&A announcements. The empirical results suggest that shareholders respond favorably to M&A transactions when target firms possess significant intangible assets, as evidenced by the statistically significant impact of both economic patent values and adjusted intangible property intensity. This is consistent with the growing literature emphasizing the strategic importance of intellectual property and intangible resources in firm valuation (Ewens, Peters, and Wang 2024; Peters and Taylor 2017).

In particular, the results are consistent with those of Kogan et al. (2017), who claim that patents serve as a reliable proxy for innovation capabilities because they represent formalized and market-valued knowledge capital. This is also supported by the significant coefficients for the economic value of patents, suggesting that patents are perceived by the market as valuable assets that contribute to a firm's long-term competitiveness and profitability. The findings also highlight that, in addition to formal intellectual property, other factors such as the intensity of further

intangible assets play a major role in shaping market perception. The short-term positive effects show that historical SGA and R&D investments that have not led to patents are perceived positively by shareholders and may also be used by them as an indicator of knowledge. The observed decline in the significance of adjusted intangible intensity in the longer event window [-3, 3] suggests that while intangibles are critically important immediately after M&A announcements, their perceived value diminishes as investors are given more information over a longer time period. This implies that the immediate reaction to intangible assets may be driven by initial market sentiment, which gradually stabilizes as more detailed information becomes available. The negative and significant coefficients for unrealized R&D investments illustrate the conservative behavior of the market towards ongoing R&D projects. This is in line with the previous study by Lev and Sougiannis (1996), which notes the inherent uncertainty and potential risks associated with unfinished R&D activities. The consistently negative impact indicates that while R&D spending contributes to the creation of knowledge, it is often viewed as a liability rather than an asset during the short-term window surrounding the announcement of M&A. The market may therefore focus on the immediate results of the R&D, which are accompanied by uncertainty about the future benefits and risks of the integration, affecting the CAR. High SGA costs could be seen as an advantage by shareholders, as they reflect employee expertise, increased sales reach through investment in sales staff, or increased brand awareness through advertising. It should be noted that excessively high costs can also be interpreted as a sign of poor profitability, e.g. if the performance of the sales department is weak, thus opening up the potential for the acquirer to increase the target's profitability. A company with high commission payments, typically recorded in SGA expenses, tends to offer less potential for "insight knowledge" when analyzing historical costs than companies that do without such payments and instead invest in other areas of this category. R&D expenditure is spent to gain new knowledge through investment opportunities as well as to develop and improve existing products. These

investments, as explained above, face the risk that the spending does not lead to new insights or that there is no market for the developed products consistent with the study conducted. A concise overview of the pros and cons of using historical costs to estimate intangible property is available in Appendix 15. Similarly, both book values (historical values) and market values (future-oriented patent values) are compared. Instead of exact balance sheet items, the key figures are based on historical investments to reflect the economic value of intangible assets as accurately as possible. While the study uses the cost method, shareholders could use alternative approaches such as comparable valuations, which have not been considered here.

Similarly, the analysis of 10-K reports on share prices following takeovers confirms the valuation of intellectual assets. Information on intangible purchase elements is only published after completion and does not directly influence investor decisions; however, it can be used to estimate the value of intangible assets. The findings also show that customer relationships and technology increase company value and highlight the growing importance of intangible assets through globalization. Further robustness testing during bubble years suggests that only patent values are associated with higher abnormal returns. In general, patent values prove to be particularly robust, indicating that shareholders attach more importance to legally protected intangible assets or their market valuation than to book values.

The results show how important it is for managers to communicate the strategic value of intangible assets in M&A announcements, as innovation serves as a key growth driver. Companies should use the development and disclosure of their intellectual property to increase shareholder value, considering the 20-year time limit on patents and historical cost risks. In addition, as new technologies emerge, previous expenditures may lose their value as well as patents themselves may lose value. However, the acquisition of intangible assets is often only beneficial if they can be used in the long-term core business or if expansion in this direction is intended (a possible process is outlined in Appendix 16). The negative effects of unrealized R&D investments serve

as a warning signal to managers, suggesting that increased transparency regarding the status and potential outcomes of R&D projects could help alleviate market concerns. In addition to listed companies, dynamic and innovative start-ups offer great potential as takeover targets, while they are rarely listed on the stock exchange (Dijk, Moraga-González, and Motchenkova 2024). R&D and SGA figures are often inadequate here, as these are not yet established for start-ups, which may limit their influence on the market value of the acquirer.

The results of this study are consistent with previous research by Peters and Taylor (2017), who argue that traditional accounting methods fail to capture the full value of intangible assets such as knowledge and organizational capabilities. By demonstrating the importance of adjusted intangible asset intensity, I provide further evidence to support the argument that, when measured appropriately, intangible assets can provide valuable insights into the true market value of a company. However, the lack of significance of certain control variables, such as acquirer size and industry M&A intensity, despite a negative influence, contrasts with studies such as Moeller, Schlingemann, and Stulz Moeller (2004), which found that acquirer characteristics have a greater influence on explaining M&A outcomes.

The results are primarily applicable to larger companies, as already described in the limitations. In future research, the influence of takeovers of smaller companies should therefore also be analyzed. Similarly, the impact of intangible assets in the international M&A context could be analyzed to better understand cross-national differences in investor perceptions. At this point, it would be conceivable to work out differences between different cultures. Furthermore, examining the long-term effects of intangibles on shareholder value beyond the short-term event windows used in this study would allow a more holistic view of their contribution to firm performance. Exploring which specific areas offer the potential for realizing synergies would be valuable in this context. Intangible assets could be analyzed in greater detail to demonstrate how individual components impact the acquirer's market value. Target's perspective on the

share price impact should also be reviewed, allowing for the possibility that a higher purchase price may be demanded despite purchase price negotiations.

V. Conclusion

In this study, I develop a comprehensive analysis of the impact of intangible assets on shareholder value in M&A, using market reactions to capture their strategic importance. Patents and other intangible assets show a significant positive impact on CAR, supporting the theory that these resources provide strategic advantages and are recognized as value-enhancing by financial markets. The results contribute to the literature by examining the impact of various intangible assets, highlighting the consistently positive value of patents and the uncertainty associated with unrealized R&D investments. While the results are consistent with previous research on prudent market valuation of incomplete innovations and have passed robustness tests, limitations remain. The focus on US data could limit generalizability, and the emphasis on large firms in the sample could introduce bias. Future research could examine cross-border M&A and long-term effects to deepen insights into the value of intangible assets.

In practice, the findings underscore the importance of transparent communication about intangible assets in M&A announcements. Investors could refine valuation models to better account for these assets. By considering differentiated intangible assets, I extend the theories of intellectual capital and resource-based competitive advantage and show how different intangible assets affect firm valuation in unique ways. The findings suggest that strategic communication of intangibles is important for firms in the M&A context. Managers should actively communicate patent portfolios and other intangible assets during acquisitions and report transparently on active research projects of the target to optimize the acquirer's market value. Future studies could focus on examining the long-term effects of intangibles on firm performance, considering international differences in the market reaction.

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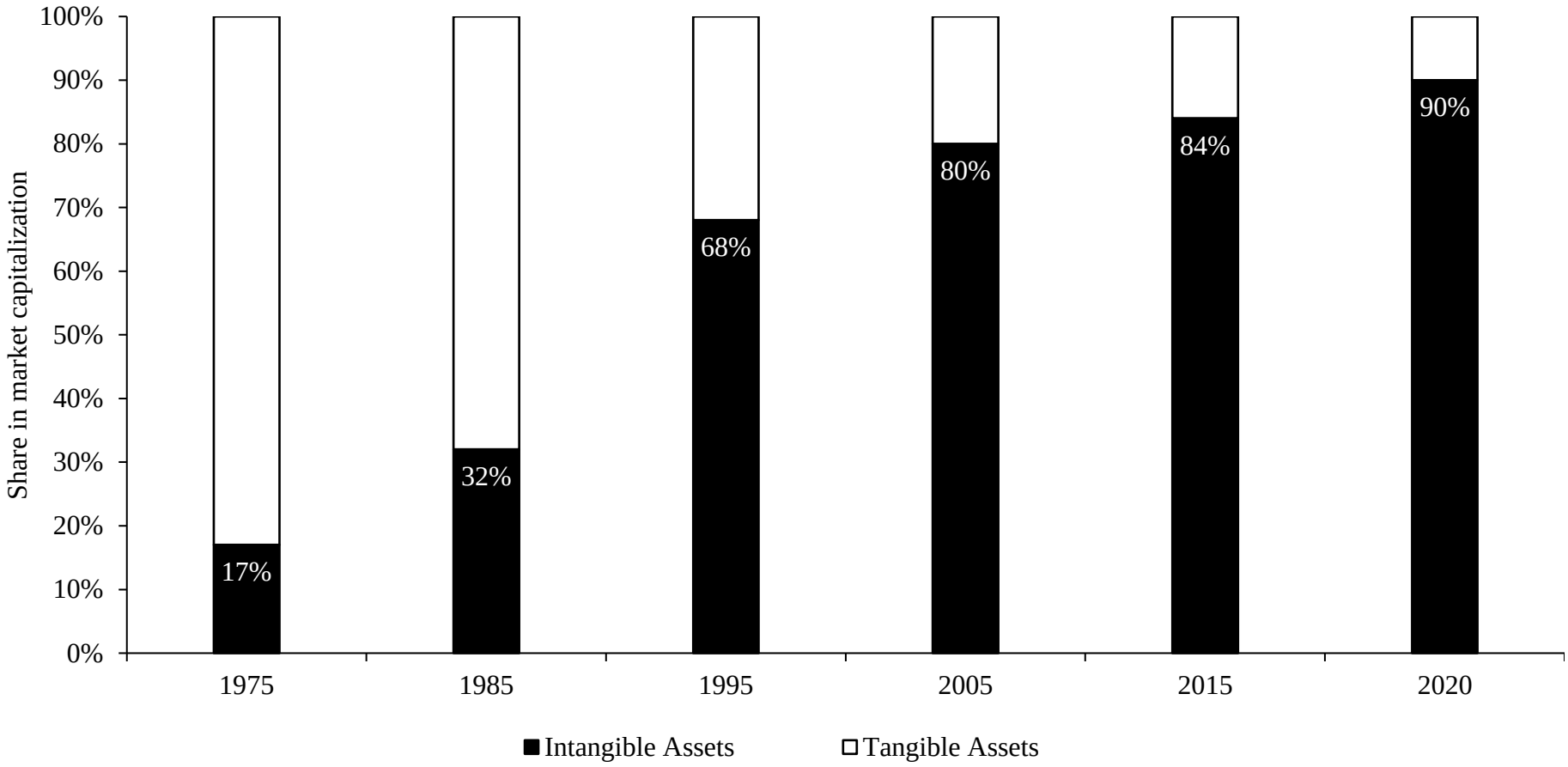
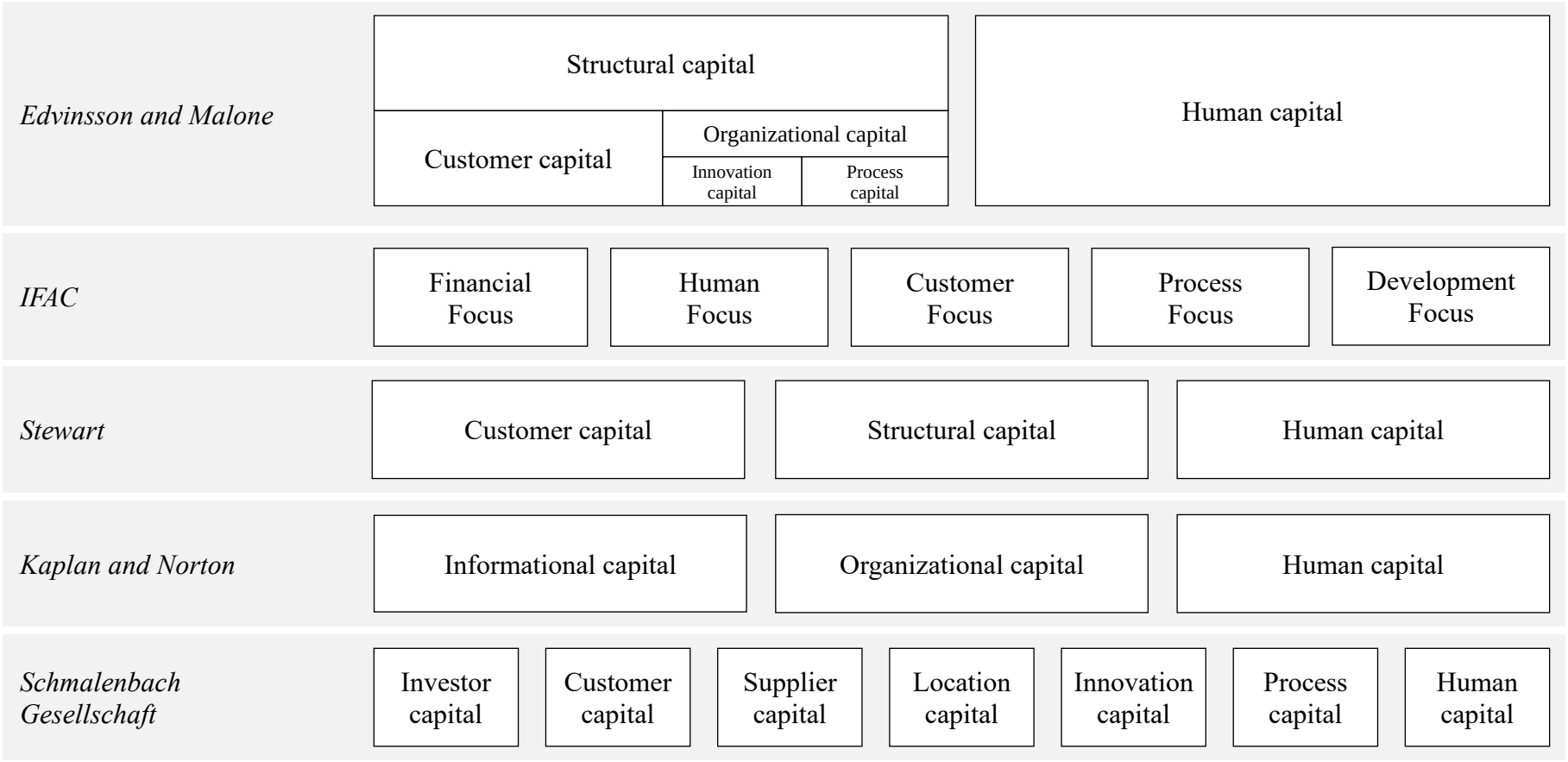
Appendix

Appendix 1. Development of the share of Intangible Assets in relation to Market Capitalization in the S&P 500



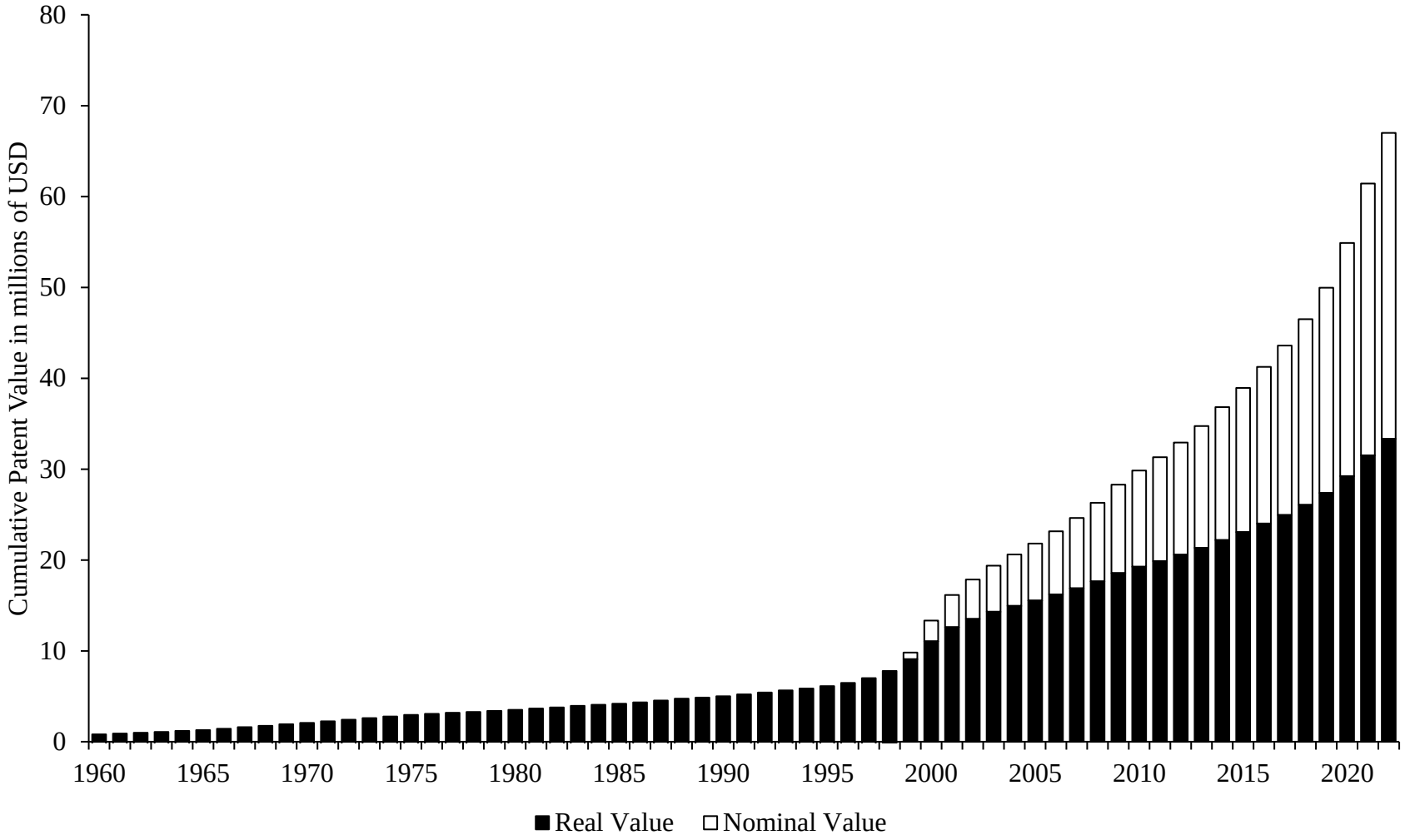
Source: Ocean Tomo (n.d.).

Appendix 2. Overview of the different dimensions of intellectual capital



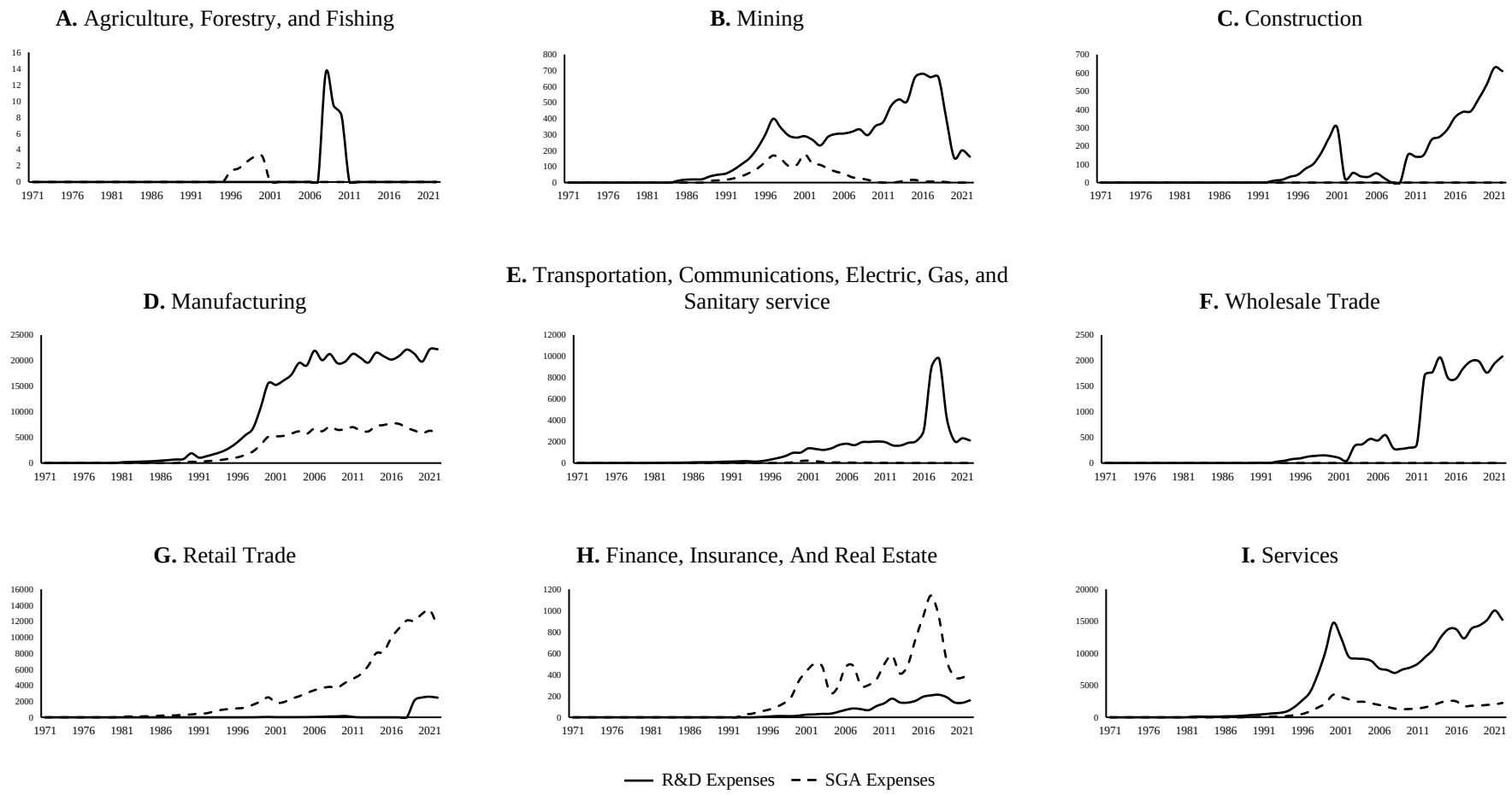
Source: Based on Will (2011).

Appendix 3. Cumulative patent value of the data set from Kogan et al. (2017)



Source: Own illustration based on Kogan et al. (2017).

Appendix 4. Evolution of SGA and R&D Expenses by Industry over Time for the Sample of M&A targets



Note: All values are in millions of USD.

Source: Own illustration.

Appendix 5. Calculation of the patent similarity (simplified) according to Bloom, Schankerman, and van Reenen (2013)

i. Calculation of technology field shares

Each company i owns several patents covering various fields of technology k are distributed. The share of a company's patents in a technology field is calculated as:

(A-1) $$subsh_{i,k} = \frac{Patents_{i,k}}{Total\ Patents_i}$$

$Patents_{i,k}$ is the number of patents held by company i in the technology field k, while $Total\ Patents_i$ is the total number of patents held by company i. This results in a vector of shares for each company $(subsh_{i,1}, subsh_{i,2}, \ldots, subsh_{i,K})$.

ii. Correlation between the companies

The similarity between two companies i and j is calculated based on the shares in all technology fields k and is calculated using the cosine similarity formula:

(A-2) $$tec_{i,j} = \frac{\sum_{k=1}^{K} subsh_{i,k} \times subsh_{j,k}}{\sqrt{\sum_{k=1}^{K} subsh_{i,k}^2} \times \sqrt{\sum_{k=1}^{K} subsh_{j,k}^2}}$$

Here, the numerator measures the scalar product of the proportion vectors, which measures the joint distribution over technology fields. The denominator measures the product norms of the vectors to account for the length of the vectors. $tec_{i,j}$ is between 0 and 1, with 0 indicating no overlap between the technology fields and 1 indicating a perfect match between the technology fields.

iii. Matrix representation

For all companies (i, j) a pairwise similarity matrix is created:

(A-3) $$TEC_{N\times N} = \begin{bmatrix} tec_{1,1} & tec_{1,2} & \ldots & tec_{1,N} \\ tec_{2,1} & tec_{2,2} & \ldots & tec_{2,N} \\ \vdots & \vdots & \ddots & \vdots \\ tec_{N,1} & tec_{N,2} & \cdots & tec_{4,N} \end{bmatrix}$$

Appendix 6. Overview of the variables used in the analysis

Variable	Description	Source
Variables in the main analysis		
EPA	Economic patent values, are calculated based on patent-related market value and share prices according to the methodology of Kogan et al. For each company, the EPA (Economic Patent Assets) results from the EPV_j, as the sum of all patent values up to the effective date of the announcement, adjusted by the similarity score.	Kogan et al. (2024) and Bloom, Schankerman, and van Reenen (2013)
Adjusted Intangible Property Intensity	Sum of historical R&D and SGA investments, adjusted using the amortization rates provided by Bureau of Economic Analysis (2024), with data dating back to 1962. The calculation includes all historical SGA costs up to the announcement date and R&D costs up to one year prior, with patent values subtracted in the final step.	Compustat - Capital IQ, Bureau of Economic Analysis (2017) and Kogan et al. (2024)
Unrealized R&D	Ongoing R&D expenditures in the last 12 months are considered as a ratio to revenue to capture projects still in progress.	Compustat - Capital IQ
Acquirer Size	Logarithm of the acquirer's market capitalization 10 days prior to the announcement to account for economies of scale.	Compustat - Capital IQ
Leverage Ratio	Ratio of liabilities to the total assets reported by the acquirer.	Compustat - Capital IQ
Value of last M&A activities	Cumulative value of the acquirer's M&A transactions over the last 10 years.	SDC Platinum
Intensity of M&A market	HHI is based on the cumulative 10-year M&A transaction values in the acquirer's industry. Industries falling within the top 20% of M&A market concentration are assigned a dummy variable to indicate high market dominance.	SDC Platinum and Compustat - Capital IQ
Market Performance	Average market return (S&P 500 Index) over the 60 trading days before the announcement.	Compustat - Capital IQ
Variables in the robustness analysis		
In-process R&D	Captures incomplete R&D projects, using natural logarithm transformations for comparability.	Ewens, Peters, and Wang (2024)
Patents	Specified value for patents in the 10-K report.	Ewens, Peters, and Wang (2024)
Adjusted Intangible Property	Sum of trademarks, trade names, brands, technology, workforce, non-compete agreements, maintenance support contracts, customer relationships contracts, and contractual rights.	Ewens, Peters, and Wang (2024)

Note: Non-existent data that does not necessarily have to be available, such as historical R&D expenses, is set to 0 in the study.

Appendix 7. Regression results in the five-day time window using the FF5 model

In this model, an estimation period of [-130, -10] is assumed and an event window of [-2, 2] is considered. The CAR is predicted using the FF5 model.

Independent Variable	CAR [-2, 2]				
	(1)	(2)	(3)	(4)	(5)
Intangible characteristics					
EPA	0.0022***	0.0029***	0.0028***	0.0022***	0.0024***
	(40.36)	(14.27)	(13.61)	(13.61)	(11.98)
Adjusted Intangible Property Intensity		0.0000***	0.0000***	0.0000**	0.0000**
		(4.1)	(4.03)	(2.73)	(2.59)
Unrealized R&D			-0.0016***	-0.0014***	-0.0014***
			(-15.7)	(-8.61)	(-8.19)
Acquirer characteristics					
Acquirer Size				-0.0028	-0.0030
				(-0.94)	(-1.03)
Leverage Ratio				0.0011	0.0010
				(0.17)	(0.15)
Value of last M&A activities				-0.0017	-0.0017
				(-1.45)	(-1.51)
Industry characteristics					
Intensity of M&A market					0.0208
					(1.23)
Market characteristics					
Market Performance					6.1620***
					(3.67)
Sector Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	1140	1140	1140	1114	1114
R^2	0.0706	0.0716	0.0768	0.0951	0.0980

Note: Patent values are included in the analysis in USD billions. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. t-statistics are reported in parentheses.

Appendix 8. Regression results in the seven-day time window using the FF5 model

In this model, an estimation period of [-130, -10] is assumed and an event window of [-3, 3] is considered. The CAR are predicted using the FF5 model.

Independent Variable	CAR [-3, 3]				
	(1)	(2)	(3)	(4)	(5)
Intangible characteristics					
EPA	0.0024***	0.0032***	0.0031***	0.0024***	0.0026***
	(26.5)	(6.81)	(6.72)	(6.88)	(7.81)
Adjusted Intangible Property Intensity		0.0000	0.0000	0.0000	0.0000
		(1.75)	(1.73)	(0.88)	(0.87)
Unrealized R&D			-0.0017***	-0.0015***	-0.0015***
			(-15.33)	(-7.62)	(-7.74)
Acquirer characteristics					
Acquirer Size				-0.0029	-0.0031
				(-0.98)	(-1.06)
Leverage Ratio				0.0074	0.0074
				(1.05)	(1.01)
Value of last M&A activities				-0.0020	-0.0021
				(-1.41)	(-1.52)
Industry characteristics					
Intensity of M&A market					0.1094**
					(3.39)
Market characteristics					
Market Performance					8.9442***
					(5.2)
Sector Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	1139	1139	1139	1113	1113
R^2	0.0692	0.0702	0.0744	0.0934	0.1031

Note: Patent values are included in the analysis in USD billions. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. t-statistics are reported in parentheses.

Appendix 9. Regression results in the three-day time window using the FF3 model

In this model, an estimation period of [-130, -10] is assumed and an event window of [-1, 1] is considered. The CAR are predicted using the FF3 model.

Independent Variable	CAR [-1, 1]				
	(1)	(2)	(3)	(4)	(5)
Intangible characteristics					
EPA	0.0029***	0.0036***	0.0035***	0.0031***	0.0033***
	(76.13)	(17.42)	(16.86)	(18.29)	(17.62)
Adjusted Intangible Property Intensity		0.0000**	0.0000**	0.0000***	0.0000***
		(3.62)	(3.53)	(6.02)	(6.39)
Unrealized R&D			-0.0015***	-0.0014***	-0.0013***
			(-23.8)	(-13.17)	(-14.43)
Acquirer characteristics					
Acquirer Size				-0.0007	-0.0010
				(-0.31)	(-0.48)
Leverage Ratio				0.0041	0.0039
				(0.94)	(0.85)
Value of last M&A activities				-0.0018**	-0.0017**
				(-2.67)	(-2.81)
Industry characteristics					
Intensity of M&A market					-0.0082
					(-0.69)
Market characteristics					
Market Performance					7.9882***
					(3.74)
Sector Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	1142	1142	1142	1116	1116
R^2	0.0674	0.0685	0.0746	0.0912	0.0971

Note: Patent values are included in the analysis in USD billions. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. t-statistics are reported in parentheses.

Appendix 10. Regression results in the five-day time window using the FF3 model

In this model, an estimation period of [-130, -10] is assumed and an event window of [-2, 2] is considered. The CAR are predicted using the FF3 model.

Independent Variable	CAR [-2, 2]				
	(1)	(2)	(3)	(4)	(5)
Intangible characteristics					
EPA	0.0022***	0.0029***	0.0028***	0.0022***	0.0024***
	(40.36)	(14.27)	(13.61)	(13.61)	(11.98)
Adjusted Intangible Property Intensity		0.0000***	0.0000***	0.0000**	0.0000**
		(4.1)	(4.03)	(2.73)	(2.59)
Unrealized R&D			-0.0016***	-0.0014***	-0.0014***
			(-15.7)	(-8.61)	(-8.19)
Acquirer characteristics					
Acquirer Size				-0.0028	-0.0030
				(-0.94)	(-1.03)
Leverage Ratio				0.0011	0.0010
				(0.17)	(0.15)
Value of last M&A activities				-0.0017	-0.0017
				(-1.45)	(-1.51)
Industry characteristics					
Intensity of M&A market					0.0208
					(1.23)
Market characteristics					
Market Performance					6.1620***
					(3.67)
Sector Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	1140	1140	1140	1114	1114
R^2	0.0706	0.0716	0.0768	0.0951	0.0980

Note: Patent values are included in the analysis in USD billions. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. t-statistics are reported in parentheses.

Appendix 11. Regression results in the seven-day time window using the FF3 model

In this model, an estimation period of [-130, -10] is assumed and an event window of [-3, 3] is considered. The CAR are predicted using the FF3 model.

Independent Variable	CAR [-3, 3]				
	(1)	(2)	(3)	(4)	(5)
Intangible characteristics					
EPA	0.0024***	0.0032***	0.0031***	0.0024***	0.0026***
	(26.5)	(6.81)	(6.72)	(6.88)	(7.81)
Adjusted Intangible Property Intensity		0.0000	0.0000	0.0000	0.0000
		(1.75)	(1.73)	(0.88)	(0.87)
Unrealized R&D			-0.0017***	-0.0015***	-0.0015***
			(-15.33)	(-7.62)	(-7.74)
Acquirer characteristics					
Acquirer Size				-0.0029	-0.0031
				(-0.98)	(-1.06)
Leverage Ratio				0.0074	0.0074
				(1.05)	(1.01)
Value of last M&A activities				-0.0020	-0.0021
				(-1.41)	(-1.52)
Industry characteristics					
Intensity of M&A market					0.1094**
					(3.39)
Market characteristics					
Market Performance					8.9442***
					(5.2)
Sector Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	1139	1139	1139	1113	1113
R^2	0.0692	0.0702	0.0744	0.0934	0.1031

Note: Patent values are included in the analysis in USD billions. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. t-statistics are reported in parentheses.

Appendix 12. Regression results in the three-day time window using the Market Model

In this model, an estimation period of [-130, -10] is assumed and an event window of [-1, 1] is considered. The CAR are predicted using the Market Model based on the S&P 500 index.

Independent Variable	CAR [-1, 1]				
	(1)	(2)	(3)	(4)	(5)
Intangible characteristics					
EPA	0.0029***	0.0036***	0.0035***	0.0031***	0.0033***
	(76.13)	(17.42)	(16.86)	(18.29)	(17.62)
Adjusted Intangible Property Intensity		0.0000**	0.0000**	0.0000***	0.0000***
		(3.62)	(3.53)	(6.02)	(6.39)
Unrealized R&D			-0.0015***	-0.0014***	-0.0013***
			(-23.8)	(-13.17)	(-14.43)
Acquirer characteristics					
Acquirer Size				-0.0007	-0.0010
				(-0.31)	(-0.48)
Leverage Ratio				0.0041	0.0039
				(0.94)	(0.85)
Value of last M&A activities				-0.0018**	-0.0017**
				(-2.67)	(-2.81)
Industry characteristics					
Intensity of M&A market					-0.0082
					(-0.69)
Market characteristics					
Market Performance					7.9882***
					(3.74)
Sector Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	1142	1142	1142	1116	1116
R^2	0.0674	0.0685	0.0746	0.0912	0.0971

Note: Patent values are included in the analysis in USD billions. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. t-statistics are reported in parentheses.

Appendix 13. Regression results in the five-day time window using the Market Model

In this model, an estimation period of [-130, -10] is assumed and an event window of [-2, 2] is considered. The CAR are predicted using the Market Model based on the S&P 500 index.

Independent Variable	CAR [-2, 2]				
	(1)	(2)	(3)	(4)	(5)
Intangible characteristics					
EPA	0.0022***	0.0029***	0.0028***	0.0022***	0.0024***
	(40.36)	(14.27)	(13.61)	(13.61)	(11.98)
Adjusted Intangible Property Intensity		0.0000***	0.0000***	0.0000**	0.0000**
		(4.1)	(4.03)	(2.73)	(2.59)
Unrealized R&D			-0.0016***	-0.0014***	-0.0014***
			(-15.7)	(-8.61)	(-8.19)
Acquirer characteristics					
Acquirer Size				-0.0028	-0.0030
				(-0.94)	(-1.03)
Leverage Ratio				0.0011	0.0010
				(0.17)	(0.15)
Value of last M&A activities				-0.0017	-0.0017
				(-1.45)	(-1.51)
Industry characteristics					
Intensity of M&A market					0.0208
					(1.23)
Market characteristics					
Market Performance					6.1620***
					(3.67)
Sector Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	1140	1140	1140	1114	1114
R^2	0.0706	0.0716	0.0768	0.0951	0.0980

Note: Patent values are included in the analysis in USD billions. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. t-statistics are reported in parentheses.

Appendix 14. Regression results in the seven-day time window using the Market Model

In this model, an estimation period of [-130, -10] is assumed and an event window of [-3, 3] is considered. The CAR are predicted using the Market Model based on the S&P 500 index.

Independent Variable	CAR [-3, 3]				
	(1)	(2)	(3)	(4)	(5)
Intangible characteristics					
EPA	0.0024***	0.0032***	0.0031***	0.0024***	0.0026***
	(26.5)	(6.81)	(6.72)	(6.88)	(7.81)
Adjusted Intangible Property Intensity		0.0000	0.0000	0.0000	0.0000
		(1.75)	(1.73)	(0.88)	(0.87)
Unrealized R&D			-0.0017***	-0.0015***	-0.0015***
			(-15.33)	(-7.62)	(-7.74)
Acquirer characteristics					
Acquirer Size				-0.0029	-0.0031
				(-0.98)	(-1.06)
Leverage Ratio				0.0074	0.0074
				(1.05)	(1.01)
Value of last M&A activities				-0.0020	-0.0021
				(-1.41)	(-1.52)
Industry characteristics					
Intensity of M&A market					0.1094**
					(3.39)
Market characteristics					
Market Performance					8.9442***
					(5.2)
Sector Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	1139	1139	1139	1113	1113
R^2	0.0692	0.0702	0.0744	0.0934	0.1031

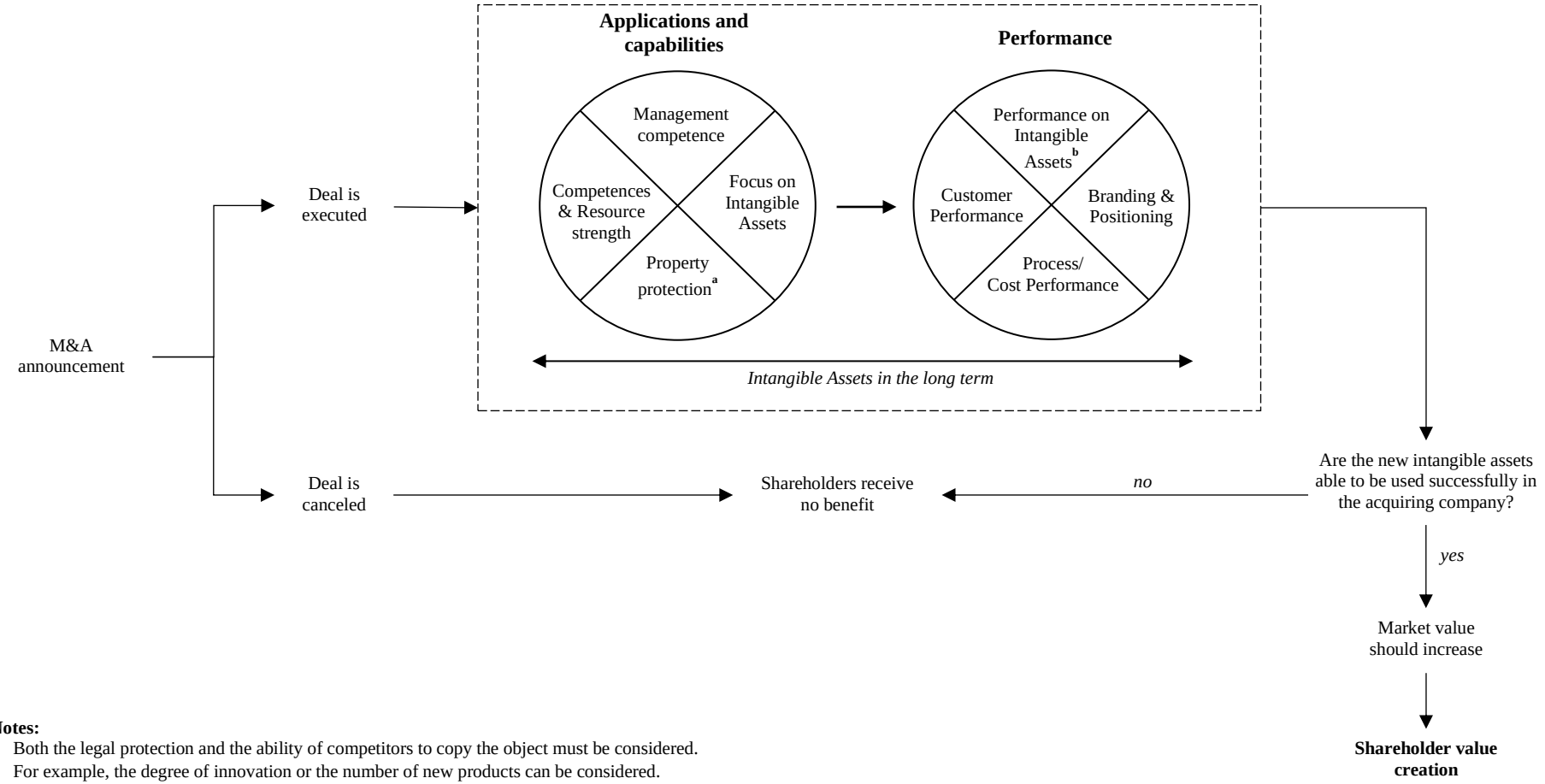
Note: Patent values are included in the analysis in USD billions. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. t-statistics are reported in parentheses.

Appendix 15. Advantages and disadvantages of using historical costs as an estimation method for determining intangible property

Aspect	Advantages	Disadvantages
Data availability	• Historical cost data is often readily available in financial reports.	• Historical costs do not reflect the current market value of intangible assets.
Simplicity	• Easier to calculate compared to market-based valuations.	• The future economic benefits of the expenditure are not captured.
Consistency	• Provides a consistent approach for comparing different companies or time periods.	• Dependent on consistent accounting practices, which may vary from company to company.
Cost approach	• Reflects the company's actual expenditure on R&D and SGA.	• Does not consider impairment due to relevance or obsolescence over time.
Regulatory focus	• Reflects accounting standards, which are often based on historical cost measures.	• Does not consider how effectively costs can be converted into value added.
Focus on inputs	• Emphasizes investment efforts in innovation and organizational capabilities.	• Does not consider the output or success of these efforts, such as patents or market reach.
Transparency	• Transparent and verifiable data source.	• Unquantified elements such as employee expertise or brand value may be ignored.
Industry-specific relevance	• Allows comparisons within industries where R&D intensity varies widely.	• Unsuitable for rapidly developing industries where intangible assets dominate.

Source: Own illustration.

Appendix 16. Possibility of increasing shareholder value through intangible assets in M&A



Notes:
[a] Both the legal protection and the ability of competitors to copy the object must be considered.
[b] For example, the degree of innovation or the number of new products can be considered.

Source: Own illustration based on Gerybadze and Gaiser (2005).