Drivers and Effects of Radical vs. Incremental Innovation Purchases

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Abstract

I examine whether acquirers can exploit the stock of innovative ideas of targets in a sample of public-to-public M&A deals. I distinguish between radical innovation, which involves cutting-edge technologies that are influential for a wide range of future technologies, and incremental innovation, which leverages already established innovations in new ways. Using a new hand-collected database that has market values for radical and incremental innovations, I provide two sets of findings. First, the purchased innovations positively influence the sales growth of the new entity through the adoption of new technologies. Second, acquirers relying on scope and scale tend to pursue acquisitions focused on radical innovation, whereas cash-endowed acquirers gravitate towards incremental innovations.

Keywords: Innovation, R&D, Radical and incremental technologies, Acquisitions, Mergers

JEL Classification: G34, M10, O31, O34

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Introduction

Innovation activity is widely considered to be the main driver of long-term economic growth[1]. Much evidence shows that mergers and acquisitions (M&A) serve as a strategic tool for firms to enhance their innovative capabilities through integrating the intellectual assets of target companies[2]. In recent decades, discussions surrounding intellectual property protection and methods for assessing successful innovations have intensified, focusing on their value for the firms and their shareholders. In this paper, I analyze the feasibility of integrating a purchased innovation stock into a newly formed entity, focusing on how this integration differs due to the heterogeneous nature of the innovations involved.

Given the uncertainty and diversity in the value of innovations, I differentiate between radical and incremental innovations using a hand-collected database by developing separate dollar value measures for each type of innovation. I focus on two main questions: What factors might predict whether an acquiring firm will purchase radical or incremental innovations? How does the acquisition of different types of innovations affect future outcomes for the new entity, such as innovativeness, market expansion, and effectiveness? The main findings of my paper are that the dollar value of innovations enhances the sales growth of the newly formed entity. Additionally, purchased radical innovations predict future radical innovations within the new entity, while purchased incremental innovations lead to production cost reduction. My approach highlights how acquiring firms can effectively leverage the innovative potential of their targets to drive future growth and market success. I also demonstrate that the characteristics of acquiring companies predict their acquisition of innovations. For instance, companies emphasizing scale effects tend to acquire radical innovations, whereas cash-rich acquirers are inclined to purchase incremental innovations.

[1] (see, e.g., Solow, 1957; Aghion and Howitt, 1992)

[2] (see, e.g., Hoberg and Phillips, 2010; King et al., 2008; Bena and Li, 2014)

To investigate how acquiring companies differ in their approach to purchased technology and how they can leverage acquired innovations, I create a new database that captures the dollar value of purchased innovations from target firms involved in public-to-public US M&A deals. This approach became feasible following the enactment of *U.S. Financial Accounting Standards No. 141 and No.* in 2001, which mandate detailed reporting of acquired intangible assets. I manually collect a unique dataset that includes Purchase Price Allocation (PPA) information for each public-to-public M&A deal from 2001 to 2021. My dataset comprises 1,796 transactions totaling $4.85 trillion, executed by 1,171 acquirer firms. Despite some firms reporting incomplete or zero intangible assets, technology-related intangible assets on average account for 18% of the aggregate purchase price. Additionally, I gathered information on patents granted to target and acquiring firms using *United States Patent and Trademark Office* (USPTO) database and the publicly available dollar value of patents provided by Kogan et al. (2017).

Kogan and Papanikolaou (2019) describe innovation as the process of translating new ideas or inventions into production factors that create economic value. Therefore, innovations encompass more than just patents, with definitions varying by context. In highly innovative sectors, companies view innovation as the creation of entirely new products. In less innovative sectors, it involves adapting existing technologies to local needs or developing new technologies based on cutting-edge inventions. I use the terms radical and incremental innovation to describe these two types. Radical innovations are groundbreaking technologies that extend the technological frontier and significantly impact multiple industries and future developments. Incremental innovations refine and improve existing technologies, enhancing productivity and efficiency, reducing costs, and optimizing processes.

As the business models of target firms differ in their innovation strategies, I expect that the characteristics of acquirers also vary depending on the purchased technology.

Moreover, I expect that the consequences of acquiring different innovation strategies differ, particularly in terms of future innovation performance. I provide empirical evidence on how radical and incremental innovations influence sales growth, cost reduction, and innovation performance of newly formed firms through leveraging of purchased technologies.

Although the distinction between radical and incremental innovations is subtle and not based solely on patents, these innovations serve different goals and incentives. One of the important novelties of my work is the empirical identification of firms that engage in incremental innovation activities. This separation is of crucial importance for several reasons. Firstly, focusing only on patent-based radical innovation may lead to an underestimation of the overall impact of innovation activity. Secondly, the production of cutting-edge technology and its application to the business model is significantly different.

A significant contribution of this paper is addressing the challenge of measuring innovations. I evaluate the market value of innovation activities developed by firms, which are disclosed following M&A transactions, and develop dollar measures for both radical and incremental innovations. The measure for radical innovation is based on patents, using the dollar value approach introduced by Kogan et al. (2017). The incremental innovation metric leverages the fair value of innovations available in M&A transactions, as reported in PPA SEC 10-K(Q) files one year after deal completion. The importance of measuring technologies beyond high-quality patents is evident in my sample. I demonstrate that the dollar value of innovations does not strongly correlate with patent-based metrics, indicating that the latter fails to provide a comprehensive picture of a firm's innovation activity. Some innovations, lacking scientific novelty for patenting, might still hold significant industry value. Previous literature predominantly relies on patents due to the challenge of valuing intangible assets, leaving the impact of incremental innovations largely unknown. Leveraging insights from independent advisors during M&A transactions, I tap into assessments of the market value of incremental technologies.

I demonstrate that acquiring companies tend to continue the innovation activity of the target company post-merger. Specifically, purchased radical innovations and the quality of subsequent patents are positively related. This can be attributed to the positive influence of acquired radical intangibles and the strategic selection of targets by acquiring companies. On the contrary, the radical innovations of the acquired company do not seem to influence the sales growth of the combined entity. This suggests that integrating cutting-edge technologies obtained through M&A transactions is a complex process that does not guarantee immediate commercial success. While radical innovations do not strongly affect sales, the acquisition of incremental and radical innovations together positively relates to the sales of the newly formed entity. The result indicates that the newly formed entity can effectively adopt and assimilate acquired technologies, leading to increased sales growth. My finding supports the idea of complementary innovations and underscores the importance of effectively integrating acquired technologies. Regarding the relationship between acquired technologies and cost reduction, incremental innovations contribute to immediate operational efficiencies, as evidenced by reduced costs of goods sold for the newly formed firms.

My findings provide a new perspective on the synergy effects achieved by companies through M&A transactions. They highlight how various types of innovations work together rather than compete in the process of adopting technology, suggesting that acquirers do not necessarily overhaul the target's business models but rather select firms with innovative strategies they admire or adapt their own strategies to align with those of the target company.

The next set of tests addresses how the strategic orientations of acquiring firms (e.g., reliance on scale, scope, or cash reserves) influence their propensity to pursue radical versus incremental innovations. I show that distinct business models, cash holding levels, and capital structures are key determinants in the acquisition of radical versus incremental innovations. Specifically, companies with business models emphasizing scale or network effects are more likely to purchase radical innovations, which are more valuable when implemented at a large scale[3].

The acquisition of incremental innovations is associated with significant cash holdings, which appears economically plausible. Firstly, the value of incremental innovations, which are less noticeable and have weak legal protection, remains more ambiguous. Secondly, cash resources are necessary to incorporate acquired incremental innovations promptly. Consequently, firms with substantial cash holdings can avoid increasing their risk profile after a deal and effectively adopt acquired incremental intangible assets, even though there is no strong correlation between cash holdings and deals that were entirely completed with cash.

Additionally, the existence of radical innovation activity in acquirer firms is a crucial factor in the decision to purchase any technology. These findings underscore the divergent incentives that drive acquisitions of different innovation types, highlighting that innovation strategy is not a random choice but a strategic decision defining the renewal or development of a firm.

The papers that most closely relate to mine are Bena and Li (2014), Ewens et al. (2024), and Beneish et al. (2022). Bena and Li (2014) investigate the link between patent portfolios, R&D expenses, and M&A activities. They show that firms with large patent portfolios and low R&D expenses are more likely to be acquirers, and post-acquisition, acquirers with prior technological links to their targets tend to generate more patents. In contrast to their approach, I focus on the market value of innovations based on PPA files, which account not only for patents but also other developing and developed technologies. Ewens et al. (2024) propose a novel measure of intangible capital using transaction prices,

[3] As a proxy for scale or network effects, I use foreign income scaled by total assets.

particularly PPA files, and highlight that PPA captures the true value of intangibles more accurately than other commonly used measures. I use PPA information to distinguish between radical and incremental innovation strategies through the market value assessment of acquired intangibles and apply it to an M&A setting. Beneish et al. (2022) concentrate on the role of unpatented innovation in merger value creation through the exploration of PPA data. They discuss the consequences of M&A deals in terms of the wealth effect for shareholders. In contrast, my study delves into the determinants of public-to-public M&A deals concerning the radical and incremental innovation strategies of target companies. Also, I analyze the impact of acquired technologies on the innovation strategies of the newly formed entities.

The rest of the paper is organized as follows. Section 1 outlines how I construct innovation measures in the M&A setting. In Section 2, I develop hypotheses. Section 3 includes the sample construction procedure, data description, and summary statistics of the main variables. In Section 4, I present the main results, including the determinants of purchased technologies and the general consequences of mergers for the innovation activity of the new entity. I conclude in Section 5.

1 Derivation of main innovation measures

In this section, I introduce my innovation measures and address the conceptual benefits and challenges of my approach.

1.1 Definition of radical vs incremental innovations

A substantial body of literature highlights innovation as a crucial driver of growth in the modern economy. Within the realm of economics and finance, theoretical papers explore the influence of innovation on the economy, the technology behind the innovation process, and the incentives motivating companies to do groundbreaking research (see e.g., Che and Gale, 2003; Manso, 2011; Akcigit et al., 2016; Akcigit and Kerr, 2018; Malamud and Zucchi, 2019). However, theoretical models often lack a precise empirical definition of innovation and frequently do not distinguish between various forms of innovation.

The empirical literature has recently attempted to distinguish between radical and incremental innovation due to the heterogeneous nature of research and development activities. Radical innovations impact a wide range of industries and shift the innovation frontier, while incremental innovations influence business processes by enhancing productivity and reducing costs (Acemoglu et al., 2022; Kogan et al., 2020; Caggese, 2019; Kerr and Nanda, 2015; Nanda and Rhodes-Kropf, 2013). Kerr and Nanda (2015), for instance, define radical innovations in terms of patents by measuring *originality* and *generality* – which identify highly cited patents and patents affecting a broad set of subsequent patent classes. The rest of the patents outside the top tier by *originality* and *generality* corresponds to incremental innovation.

In my research, I also categorize innovation into two types: radical and incremental innovations. However, I contribute to the literature through an innovative, non-patent-based approach to valuing incremental innovation. Similar to the literature, a company's radical innovations are characterized by advanced patented technologies. On the other hand, incremental innovations encompass developed technologies, innovations with patents that do not significantly expand existing boundaries, unpatentable technologies, and early-stage projects aimed at building upon existing groundbreaking technologies.

The separation between *radical* and *incremental* innovation activities is significant for several reasons. Firstly, focusing only on radical innovation may lead to an underestimation of the overall impact of innovation activity. Secondly, the nature of the production of cutting-edge technology and its application to the business model is significantly different. Acemoglu et al. (2022) provide a model distinguishing between radical and incremental innovation, where the intensity of innovation production is an endogenous choice of a firm. The authors define *high-type* firms as those having a comparative advantage in radical innovations, while *low-type* firms are incapable of producing radical innovations at all but might exogenously switch types in the model. However, both types can effectively produce incremental innovations.

In my study, I offer empirical evidence demonstrating distinct innovation activities across companies by evaluating the market value of innovations produced by firms. I illustrate that firms prone to produce incremental innovation differ in their intensity of incremental innovation production, which creates a third non-innovative group of companies. Therefore, in addition to companies that actively pursue either type of innovation, there are those that generate no innovations at all. It's noteworthy that companies may engage in the production of both types of innovations, or they may choose not to innovate altogether.

1.2 Value of innovations

Valuing innovations created by companies is a complex task. Empirical studies employ various metrics to gauge a company's innovation activities, with widely used measures including R&D expenditures or capitalized R&D expenditures, and patent-based or patent-citation metrics.

The literature frequently relies on *R&D expenditures* (see, e.g., Titman and Wessels, 1988) or *capitalized R&D expenditures* (see, e.g., Glaeser et al., 2020) as innovation measures. The reliance on *R&D expenditures* stems from the fact that the balance sheets of U.S. firms do not include the value of internally generated intellectual property (IP) intangibles - like patents, trademarks, copyrights, and trade secrets. Instead, the associated costs of creating them (e.g., research and development costs) are expensed on the income statement as they are incurred. However, relying solely on R&D expenses has limitations.

It measures the input into innovative activities rather than the output. Importantly, innovation production tends to skew heavily, as noted, for example, by Scherer and Harhoff (2000). Additionally, firms tend to smooth R&D expenditures, as highlighted by Brown et al. (2012). Hence, utilizing an input as a proxy for an output, even if capitalized, may not be an effective solution to determine the value of innovation.

To address these limitations, some studies turn to patent-based metrics (see, e.g., Hall et al., 2005). Lerner and Seru (2021) provide statistics that the share of papers containing the phrase "patent citation[s]" and citing top finance journals rose from 0.1% in 1990 to 2.65% between 2018 and 2020. Nevertheless, this approach also poses certain limitations. One key point to consider is that innovation is not solely defined by the invention. Relying solely on patent-based metrics for measurement might lead to misjudgments, such as labeling a company without highly-cited patents as non-innovative. The approach fails to recognize the potential for valuable non-patentable incremental innovations within a particular company, distinguishing it from firms that do not generate any innovative solutions at all. Moreover, patent-based measures primarily provide quantitative insights into scientific outcomes rather than economic ones, which is a focal point for finance research.

Financial economists often focus on market values, and the quest for such values for innovation activities has led to the development of an alternative patent-based measure proposed by Kogan et al. (2017, further KPSS). This measure, based on stock market reactions to the patent announcements, provides a dollar value for patents. The KPSS measure's design involves two main steps. Firstly, it identifies the window of the price reaction to the patent on its grant date, utilizing patents sourced from the USPTO. Then, it isolates the patent's value from overall stock returns during this window. This approach assumes that the market value of a patent is known before its grant, focusing on abnormal share turnover around patent issuance days. Estimating the patent's economic value considers market capitalization and the count of patents issued to the firm on the same day.

But even with these measures, the valuation does not encompass the total market value of innovations, because they do not extend beyond those protected by patents. The question arises: What is the market value of innovative activities within companies? There is a specific context where the market value of a firm's innovations becomes apparent. This information is accessible in the specific setting of M&A transactions. In M&A deals, the acquiring company must publish a market-value-based evaluation of purchased technology-based intangible assets, assessed by independent advisors. This restricted but insightful setting allows for the construction of radical and incremental innovation measures. It provides a more holistic understanding of a company's innovative activities, enhancing the insights offered by conventional proxies.

1.3 Purchase Price Allocation files

The incremental measure of innovation is built on the fair value of the developed and developing technologies available for M&A transactions. Estimations of the fair value of major classes of intangible assets acquired during the M&A deal are available since the passage of *U.S. Statement of Financial Accounting Standards No. 141 and Statement No. 142 in 2001.* The Financial Accounting Standard Board (FASB) proposed a new accounting rule requiring companies to report detailed information regarding the acquired intangible assets, known as Purchase Price Allocation (PPA). The data must be disclosed in 10-K or 10-Q, filled by the acquirer company after deal completion with the US SEC. Each PPA file includes information on the fair dollar value of innovations developed by the target firm prior to the M&A deal, assessed by an independent advisor. A few existing studies are based on PPA files and often focus on goodwill or unpatented innovations (see, e.g., Beneish et al., 2022; Ewens et al., 2024), but a comprehensive dataset categorizing intangible assets in M&A transactions is not widely available. Consequently, I manually collect a unique data set that includes PPA information for each public-to-public M&A deal from 2001-2021. I provide a detailed description of the PPA data collection in Appendix A.

1.4 Radical vs Incremental innovations in M&A setting

I propose to measure the value of innovation in an M&A setting, in which acquirers have to allocate a market value to the purchased intangible assets separately in the Purchase Price Allocation (PPA) reports. Through the PPA files, I obtain a rare glimpse at a market-based measure of the value of innovation beyond patents. These reports disclose the fair dollar value of major classes of acquired intangible assets. For example, Table A1 Appendix A shows information from Itron's 10-K SEC filing after the 2018 acquisition of Silver Spring Network, Inc. (SSNI).

I use the PPA reports to identify intangible assets related to innovations. For instance, in Table A1 Appendix A, the dollar value of innovations is $96.3 million, comprising $81.9 million for *Core - developed technology* and $14.4 million for *In-process R&D*. I define all intangible assets related to developed and developing technologies as *$Innovations*.

The disclosure categorization does not mandate a separate category for *patents*, often combining it with other technologies. Therefore, to estimate the value of a firm's patent portfolio, I use the number of patents granted by the target firm between the IPO and M&A dates, along with their dollar value from the KPSS data. I define *radical* innovations as the sum of the dollar value of *high-quality* patents. To identify *high-quality* patents, I follow recommendations proposed by Lerner and Seru (2021) regarding industry and time adjustment. I designate a patent as *radical* if it receives a high number of citations in its cohort. This is operationalized by setting a threshold based on the percentile of citations received by all patents granted in the same industry and year. Namely, let

N_{it} denote the number of citations received by all patents in industry i in year t. Then $N_{it}(p)$ denotes the pth percentile of the industry-year distribution. All patents on the industry-year level, which received more citations than $N_{it}(0.75)$ are classified as *radical.* For each patent j granted to firm f in year t and assigned to industry i

$$I_j^{radical} = \begin{cases} 1, & cit(patent_j^f) \geq N_{it}(0.75) \\ 0, & \text{otherwise}, \end{cases} \tag{1}$$

where the $cit(patent_j^f)$ is the number of citations of patent j until the end of 2022 granted to firm f[4]. The dollar value of patent j granted in year t and valued at the time of M&A deal T is measured as follows:

$$V^{t,T}(patent_j^f) = \theta^{t,T} \times I_j^{radical} \times \xi_j^{real} \times \delta^T, \tag{2}$$

where θ is a linear decay coefficient, $\frac{20-(T-t)}{20}$, through the 20-year period; ξ_j^{real} is the fitted real value in 1982 dollars from data provided by Kogan et al. (2017), and the coefficient δ^T adjusts for the inflation between M&A date T, and 1982.

Since I know the dollar value of each patent from the KPSS data, I can estimate the dollar value of *radical* innovations produced by the target firm f at M&A date T, which is equal

$$\$Radical_f = \sum_{j=1}^{M_{T-20,T}} V^{t,T}(patent_j^f), \tag{3}$$

where $M_{T-20,T}$ is the number of patents granted by firm f during the 20-year window

[4]To make use of the citation data accumulated until 2022, I analyze the patent citation trends over time. I find that the trends are mostly parallel across all patents. Taking all patents granted in a particular industry in a given year and accounting for the top 25% (10%) based on citations after five years, the same patents remain the top-cited if I check their citation rates after ten years. In other words, the top-cited patents maintain their leading status over the years. Therefore, I do not impose specific restrictions by using citation data up to 2022.

prior to the M&A transaction[5].

Table A2 in Appendix A presents a selection of patents granted by Silver Spring Networks between IPO in 2013 and M&A in 2018. The variable ξ_{real} represents the dollar value of the patent as assessed by KPSS in 1982 dollars, while *Cites q25(q10, q1)* shows the corresponding quantile within the year-industry cohort for each patent based on the whole USPTO database. For instance, Table A2 illustrates that the patent issued on July 8, 2014, boasts a substantial dollar value, yet its citation count falls below the 10 percent quantile for the year-section cohort. This observation underscores the importance of the difference between economic and scientific values in the realm of innovation. My objective is to evaluate and incorporate additional economic value associated with innovation that may not be fully captured by patent data.

Figure 1 outlines how I separate radical and incremental innovations. The dollar value of *incremental* innovation is derived as the difference between the total innovation value, *$Innovations*, sourced from the PPA sections within the 10-K(Q) files, and the cumulative radical innovation value, $\$Radical_f$.[6]

$$\$Incremental_f = \$Innovations_f - \$Radical_f. \tag{4}$$

In my further analysis, I use fractions of *radical* and *incremental* innovations, specifically the ratios relative to all purchased innovations provided by PPA data. Using fractions rather than absolute numbers highlights the relative emphasis on radical versus incremental innovations within each company's acquisition strategy, offering a clearer

[5]The cumulative dollar value of radical innovations produced by the target firm at the M&A date is calculated using a 20-year period, representing the legal protection duration of patents, https://www.uspto.gov/web/offices/pac/mpep/s2701.html.

[6]Within my sample, the way I calculate *incremental* innovations may occasionally result in negative values. Specifically, I have identified about 120 firms where the *incremental* innovation metric assumes negative values. For methodological rigor, I have addressed this by imposing a bound of zero for the *incremental* innovations of these entities. However, it is noteworthy that employing a linear decay approach may be deemed overly simplistic when applied to these particular firms.

understanding of their strategic priorities.

To illustrate and motivate the proposed methodology, I provide specific examples of M&A deals. The initial case is the M&A deal between Itron (acquirer) and Silver Spring Network (target) on May 1, 2018. The PPA data from Itron's 10-K filling depicted in Table A1 of Appendix A reveals that Itron estimates all intangibles of Silver Spring Network at $241.1 million. *Developed Technology* and *InPR&D* are *$Innovations* in my classification, and I assign a market value of $96.3 million to *$Innovations*.

Silver Spring Network went public on March 13, 2013. The analysis encompasses all patents granted by the target firm between the M&A and IPO dates. The USPTO database indicates that Silver Spring Network issued 42 patents during this period. Since the *KPSS* data is based on market reactions, there is no market value of the patents before the IPO. I apply formula (3) to calculate the value of radical innovation. Among the 42 patents, 6 are categorized as radical within the 25th quantile. Some examples of patents are shown in Table A2 Appendix A. The weighted value of the patents is $47.54 million, resulting in $47.54 million attributed to *$Radical* and $48.76 ($96.3-$47.54) million to *$Incremental* innovations.

The second example involves the acquisition of Thoratec Corp. by the medical corporation St. Jude Medical Inc in 2015. As demonstrated in Table A3 Appendix A, innovation-related intangibles amount to $1,397 million. In the table's footnote, $714 million is attributed to in-process research and development, and $683 million is designated for technology. According to USPTO data, Thoratec granted 105 patents between its IPO in 1996 and the M&A deal in 2015. The cumulative value of the granted radical patents is $570.92 million. Consequently, the value of Thoratec's incremental innovation is $826.08 million, the difference between *$Innovations* ($1,397 million) and *$Radical* ($570.92 million).

These illustrative examples underscore a crucial point: even within industries heavily reliant on patents, such as the medical sector, the value of incremental innovation is large and could be an important reason for an acquirer to pursue the deal. Several more examples in Appendix A provide further insights, showcasing diverse scenarios within the context of M&A transactions and intangible asset valuation.

The anecdotal evidence from these examples indicates that *incremental* innovations make up a significant portion of intangible assets in M&A deals. It suggests that measuring innovation solely by the dollar value of granted patents would significantly undervalue the true extent of innovative activities. Therefore, my measure provides an important contribution by assessing incremental innovation within target firms, recognizing the diverse nature of innovations within companies.

2 Hypotheses development

In this section, I develop hypotheses how certain attributes of acquiring firms influence their choice between purchasing radical innovations versus incremental ones. Additionally, I developed hypotheses for the potential effects of acquiring radical versus incremental innovations on future innovation performance and success of the new entity.

The first inquiry aims to identify which characteristics of acquirers predict the acquisition of highly innovative firms and what attributes are intrinsic to companies inclined to acquire targets with predominantly incremental or radical innovations. The latter inquiry examines the effects of acquired innovations on the new entity, particularly focusing on the influence of purchased technology on future radical innovation produced and the success of adopting different types of innovations.

Starting with determinants, I hypothesize that acquisitions of technology-based intangible assets ($\$Innovations$) are more valuable for large-scale firms that rely heavily on a network effect based on the concept proposed by Crouzet et al. (2022). The non-rivalrous nature of intangible assets, allowing them to scale infinitely without diminishing value, contributes to higher marginal profits for firms with an extensive span or scope. Furthermore, this non-rivalry characteristic enhances synergy effects in transactions.

I propose that corporations operating in international markets and relying on scale effects prioritize radical innovations. The legal protection surrounding radical innovations makes them challenging to replicate, and their profitability is not dependent on the number of applications of this technology. As such, acquiring them is more favorable for corporations with a broader market presence. On the other hand, these corporations may find it more efficient to copy incremental innovations at a lower cost, because they are easily replicable.

At the same time, the size and international structure of these firms may have adverse effects. An extensive literature suggests that as firms grow larger and more international, they often become overly complex and bureaucratic, hindering their ability to innovate efficiently. Theoretical studies demonstrate that conglomerates can lead to suboptimal allocation of corporate capital (Rajan et al., 2000; Scharfstein and Stein, 2000). Research on multinational firms (see s.e., Gao and Chou, 2015) indicates that multinational firms tend to exhibit lower levels of innovation efficiency compared to purely domestic firms.

To assess how reliance on scale or scope effects of acquirers' business model influences innovation purchases, I propose using *Foreign income* as a proxy for scale. *Foreign income* is valuable for gauging a company's scale or network effect because it reflects the capacity to extend, reach, and enter new markets, and leverage competitive advantages globally. Overall, I hypothesize that foreign income will exhibit a positive correlation with overall acquired innovation and particularly with radical innovations, while its impact on incremental innovation purchasing is insignificant.

The radical innovation activity of acquirer firms plays an important role in shaping acquirers' business models and their capacity to engage with and comprehend innovations. It suggests a positive correlation between the acquired radical innovations and the acquirer's own radical innovation activity. On the other hand, if purchased radical innovations have the potential to rejuvenate a firm and facilitate a significant change in the entire business model, deals might occur where a non-innovative acquirer purchases a target firm with a high innovation level. Given these dynamics, I propose that the former effect—where the innovative activity of acquiring firms positively correlates with the innovations they acquire—will be more pronounced. Consequently, I anticipate that the proportion of radical innovations acquired will be influenced by the radical activity of the acquiring firm, whereas the acquisition of incremental innovations may not necessarily be linked to the radical activity of the acquirer.

Cash reserves and debt are extensively debated topics in both innovation financing (see, e.g., Atanassov et al., 2007; Brown and Petersen, 2011; He and Wintoki, 2016) and M&A financing (see, e.g., Harford, 1999). I argue that operating cash becomes particularly significant when acquiring incremental innovations due to the presence of significant information asymmetries. Identifying incremental innovations poses inherent challenges, and the impact of integrating these innovations on the productivity of the acquiring entity remains uncertain. The absence of legal protection may also drive acquirers to rapidly adopt these incremental technologies, which could necessitate additional financial resources. Conversely, in the case of radical innovations, the presence of granted patents can mitigate information asymmetries, offering positive signals for the future and potential collateral options.

The second part of the hypotheses development deals with the consequences for newly formed entities of buying targets with different innovation activities. Concerning the impact of acquired innovations on the new entity, the extensive literature on synergy effects in M&A deals (see, e.g., Hoberg and Phillips, 2010; Seru, 2014; Bena and Li, 2014; Cunningham et al., 2021; McInnis and Monsen, 2023) offers varied perspectives, yet ambiguity persists regarding the influence of acquired innovation on future performance. In the case of technology-based intangible assets, the synergy effects can be achieved through the expansion of market opportunities or cost reduction available to the acquirer company. However, intangible assets, as per Crouzet et al. (2022), possess limits to exclusivity, allowing competitors to copy them to some extent without legal recourse. In the M&A context, acquiring intangible assets implies either the inability to replicate technologies or the opportunity to obtain technology more efficiently. Consequently, the value of intangibles shapes the new entity's future innovation strategy and business model.

I hypothesize that acquired innovation positively impacts future sales growth while potentially reducing the cost of goods sold. Drawing from extensions of Schumpeterian theory in the economic growth literature, there is evidence that innovation development enhances a firm's profit maximization potential through advancements in the quality of technology or production and market expansion (see, e.g., Klette and Kortum, 2004; Lentz and Mortensen, 2008; Malamud and Zucchi, 2019). I anticipate that sales growth reflects the market expansion through the adoption of new technologies, while the cost of goods decreases due to the efficiency of production. Moreover, radical and incremental technologies tend to complement each other rather than act as substitutes.

Furthermore, I suggest that the acquisition of incremental innovation leads to a reduction in the cost of goods sold. Davis and Tomoda (2018) argue that firms invest in incremental technological improvements to lower production costs.

Concurrently, I propose that acquired radical innovation exhibits a positive correlation with subsequent radical innovation performance. It is rational to uphold the innovation framework rather than undermine it, given the counterintuitive nature of recognizing the significance of innovation and then eliminating it. Sevilir and Tian (2012) show a positive relationship between M&A activities and acquirers' post-merger innovation outcomes, especially if the target firms are innovative prior to the merger, as indicated by patent measures. Conversely, Seru (2014) demonstrates that conglomerates attempting to manage active internal capital markets exhibit signs of impaired innovativeness. If the acquirer's objective is to access patents or protect intellectual property (IP), acquiring rights rather than the entire firm is more practical. Furthermore, employees with specialized skills in these areas often struggle to transition to other roles and should be utilized effectively. Meanwhile, the motivation of employees can also be altered. Fulghieri and Sevilir (2011) indicate that in industries with high human capital intensity, mergers between competing firms can be inefficient as they diminish employee incentives to innovate. Previous research findings and theoretical predictions have not definitively resolved the issue regarding the consequences of acquired radical technology on a new entity. I address this gap in the literature by examining the entire market value of technology-based intangibles, rather than just focusing on patents.

3 Data description and summary statistics

In this section, I explain the data collection and how I create the sample. I provide a comprehensive description of the data, including summary statistics and trends observed in the sample.

3.1 Sample Construction

My M&A sample used for testing hypotheses is sourced from the *Thomson One Platinum Securities Data Company (SDC Platinum) Merger and Acquisition* database. My dataset encompasses all public-to-public US M&A deals announced between January 1, 2001, and December 31, 2021.

The choice of beginning the sample period in 2001 is due to the requirement to have comprehensive purchase price allocation data for all transactions. In Q3 2001, the FASB proposed a new accounting standard mandating companies to disclose detailed information on acquired intangible assets. Therefore, the effective dates of deals in my sample are after Q3 2001. My focus is exclusively on acquiring public firms because they disclose PPA information on acquired intangibles in their 10-K or 10-Q filings submitted to the US SEC after the deal is completed. To estimate the dollar value of patents granted to both the acquiring and target companies, I follow the procedure provided by Kogan et al. (2017). It means I have to focus on target companies that are publicly traded, as the *KPSS* measure relies on market reactions to patent grants.

After applying standard filters (see, e.g., Moeller et al., 2004), I arrive at a sample of 3,020 deals. I exclude companies with Standard Industrial Classification (SIC) codes corresponding to Financial Services, Real Estate, and Utilities, as they are not included in the *KPSS* database. To summarize, my sample selection criteria are as follows:

Step1: All Mergers and Acquisitions between January 1, 2001, to December 31, 2021[7]*.*

Step 2: Deal Status is "Completed".

Step 3: Acquirer and Target are US public companies.

Step 4: The acquirer owns less than 50% of the target six months prior to the deal announcement and controls more than 50% of the target following the transaction.

Step 5: The deal value exceeds $1 million.

The resulting dataset comprises 1,796 transactions executed by 1,171 unique firms, with a total transaction value of $4.85 trillion. I merge the dataset with additional databases, including the Standard & Poor's Compustat (*Compustat*), Center for Research

[7]Effective dates after July 1, 2001.

in Security Prices (*CRSP*), *KPSS*, and *USPTO*[8].

After completion of a merger deal, the newly-formed entity is required to disclose the fair value of acquired intangible assets, categorized in accordance with *SFAS No. 141* and *142*. The disclosure format and content of the purchase price allocation information exhibit variations across firms. *FASB* provides clear guidelines on terms such as *intangible assets* and *goodwill*, as well as the accounting method for the market price of intangible assets. The lack of specific categorization for intangibles poses challenges for automatically collecting PPA data. To obtain the PPA data, I manually screen the 10-K and 10-Q SEC files published in the year after the deal's completion. Consequently, I manually gather fair values of acquired intangible assets and classified them into eight major groups, including *Goodwill*, *In-process R&D (IPR&D)*, *Developed Technology*, *Developed Rights*, *Rights and Licenses*, *Trademarks*, *Patents*, and *Others Intangibles*, detailed in Appendix A.

Despite manual processing, it was not possible to collect information for all transactions. Some companies either disregarded the requirements or flagged the deal as *too small*, despite the explicit exclusion of transactions valued at less than $1 million. Furthermore, cases of sequential mergers or simultaneous transactions were identified and excluded. Sequential mergers, involving the acquisition of firm X by firm Y, followed by the acquisition of Y by Z in less than one year, presented challenges in disentangling the intangible assets of X and Y. Simultaneous transactions, which are common among large corporations acquiring multiple companies within a single quarter, complicate the separation of information between the target companies. Consequently, I exclude such deals from my analysis.

[8] The data important for my analysis include the patent-citation data sourced from the USPTO database and information provided by Kogan et al. (2017). The latter data is publicly available until the end of 2022, https://github.com/KPSS2017/Technological-Innovation-Resource-Allocation-and-Growth-Extended-Data.

3.2 Data Description

The distribution of deals throughout the sample period is depicted in Figure 2, aligning with prior research findings (see, e.g., Cai and Sevilir, 2012; Kim et al., 2024). During the sample period from 2001 to 2022, peak activity is observed in 2001. Given that my sample comprises only public-to-public deals, the decline in the number of deals naturally corresponds to the decrease in the number of publicly listed firms in the United States (see, e.g., Doidge et al., 2017). Within the sample of 1,796 deals, 314 (17.48%) companies have incomplete data for *Total Intangibles*. Out of the firms with known *Total Intangibles*, 86 (4.79%) report zero values for both *Total Intangibles* and *Goodwill*.

To differentiate between innovation types, I use fractions of radical and incremental innovations, defined as the ratio of the dollar value of a specific innovation type to the total value of all acquired innovations,

$$\textit{Radical Fraction} = \frac{\$Radical}{\$Innovations}; \quad \textit{Incremental Fraction} = \frac{\$Incremental}{\$Innovations}.$$

If no innovations are recognized for the target company, *$Innovations* equals zero, and I set both *Radical Fraction* and *Incremental Fraction* to zero.

When dealing with technology-based intangibles, it is crucial to conduct an accurate analysis concerning the prevalence of zero values in the data. The presence of zero values in the technology-based intangible assets or patents does not indicate missing data or accounting errors but rather implies that the company does not produce any asset of that type. It is essential to include these companies in the analysis, as they represent the full spectrum of business models.

To test hypotheses related to innovation performance and the synergistic impact of acquired innovations on the newly formed entity during the one to three-year period following the completion of an M&A deal, I develop specific measures to assess the performance of the combined entity. The performance of radical innovations of the newly formed entity is estimated based on the dollar value of high-quality patents within this three-year window. To evaluate the success in leveraging acquired innovations, I propose using measures such as marginal sales and costs scaled by sales of the newly formed entity during the same period. Detailed information on the definition of these measures is in Appendix B.

3.3 Summary statistics

Table 1 summarizes key statistics extracted from PPA tables. The table presents dollar values across eight major categories of intangible assets acquired by companies. The variable *Aggregate Purchase Price*, equivalent to the *Value of Transaction* in the *SDC Platinum* database, was gathered from either 10-K or 10-Q filings[9]. On average, *Aggregate Purchase Price* stands around $2.7 billion, with a median of $435 million. *Total intangibles* represents the total intangible assets listed in a table detailing the overall purchase price, primary assets, and liabilities, usually available prior to the *SFAS* requirements implemented in 2001.

The variable *Innovations* aggregates *Developed Technology*, *Developed Rights*, *Patents*, and *In-process R&D*. Based on additional information regarding the categorization from SEC files, I assume that the infrequent reporting for certain categories like *Developed Rights*, alongside limited use of *Patents*, suggests that the value of granted patents and developed rights are included in *Developed Technology* or *Developed Rights*. Therefore, combining them into *Innovations* seems reasonable. Other categories like *Rights & Licenses*, *Trademark*, and *Other Intangibles* are not categorized as technology-based intan-

[9]Despite minor differences between the *Value of Transaction* and *Aggregate Purchase Price*, both sources were cross-checked to ensure database accuracy. The *Value of Transaction* comes from the *SDC Platinum* database, while the *Aggregate Purchase Price* is from 10-K(Q) files. The differences between these measures are random and do not show a consistent bias. Therefore, I cross-checked these measures, and when the difference exceeded 10%, I manually verified the transaction value.

gibles but still represent a significant portion of acquired assets. In observations where 10-K(Q) tables combine the values of *Trademarks and Patents*, I assign missing values for both individual categories in my sample, *Trademark* and *Patent*. *Goodwill* is the difference between the purchase price and the fair value of assets and liabilities. It should be reported separately according to *FASB* rules. Consistent with the accounting terminology employed in SEC files, I maintain *Goodwill* as a distinct category from *Total Intangibles*[10].

The median values for both the *Aggregate Purchase Price* and all categories of intangible assets lag significantly behind the means, indicating a notable skewness in their fair values. A noteworthy observation regarding *Innovations* is that the median value equals zero in the sample. This aspect deserves more attention because it does not stem from missing data on R&D expenditures or a lack of patenting activity. Instead, it represents actual data revealing non-innovative firms that were acquired without any recognized innovations.

The sparsity of data points in Table 1 is attributable to the nature of recognized intangible assets. While some M&A transactions involve negligible intangible assets, only a small fraction of deals have zero intangible assets and goodwill simultaneously. In Table 1, the average payment for *Goodwill* is approximately \$1.4 billion (\$0.2 billion median), whereas all other intangible asset groups combined average around \$1.3 billion. *Goodwill* typically accounts for 53% of the *Aggregate Purchase Price*, with *Innovations* and *Trademark* constituting 18% and 5% respectively. The variability across intangible asset groups is primarily driven by maximum values, particularly in deals where a single technology is highly valued. Target companies in these deals have often accumulated

[10] Within my dataset, there is a deal where an acquirer firm reported negative *Goodwill* due to the purchase price being lower than the value of net assets acquired. Another case involves negative *Total Intangibles*, where the firm demonstrated a deficit in intangible assets attributed to debt linked to a particular license.

significant debt, which lowers the *Aggregate Purchase Price*[11].

In Table 2, I present summary statistics and correlations among my innovation measures. To construct measures of radical and incremental innovation, I follow the procedure described in Section 1.4. Among the 1,796 deals in the full sample, 381 lack a clear classification of technology-based intangible assets in their SEC filings.

Panel A of Table 2 provides summary statistics for the dollar values of incremental and radical innovations, as well as their respective fractions in relation to all acquired technologies (*$Innovations*) for the 1,415 deals with complete data. On average, both radical and incremental innovations amount to about $374 million with medians close to zero, indicating a skewed distribution. Despite similar average dollar values, the fractions differ significantly, with incremental innovations constituting 41% of all purchased technologies on average, compared to only 16% for radical innovations. The fractions do not sum up to one because some companies do not have any recognized innovations at all. Importantly, $\$Innovations$ represent a substantial proportion of the *Value of Transaction*, averaging 16%.

Out of 1,415 deals, 804 recognize non-zero *$Innovations*. Regarding the *Incremental Fraction*, 652 firms have a positive number of incremental technologies, with 351 of these firms having an incremental fraction of exactly 1, meaning they have no radical innovations. Regarding the *Radical Fraction*, 453 firms have a positive number of radical technologies, with 152 of these firms having a radical fraction of exactly 1, indicating they have no incremental innovations.

Panel B of Table 2 examines the pairwise correlations between various innovation

[11]As an illustrative example, consider the acquisition of *Zyla Life Sciences* by *Assertio Holdings, Inc.* in 2020. In this transaction, the fair value of the acquired intangible assets amounted to $193.4 million, whereas the *Net Assets Acquired* were valued at only $35.1 million. Consequently, the acquired intangibles represented a staggering 551% of the total purchased assets. The SEC filing for this acquisition reveals that the purchased intangible assets primarily consisted of three products developed by *Zyla Life Sciences*, https://www.sec.gov/Archives/edgar/data/1808665/ 000180866521000019/asrt-20201231.htm. This example sheds light on transactions where the driving force behind M&A activity is the acquisition of specific technologies that might significantly increase the dollar value of the net assets of the company.

metrics. The correlation matrix is particularly informative because the measures I developed are designed to assess different aspects of the innovation produced by target firms. If these measures were merely proportional to existing ones like patent-based metrics, constructing them and extracting this information from SEC files would be unnecessary.

The correlation between *Radical* and *Incremental* innovations is less than 0.26 and is negative. The correlation between all innovations (*$Innovations* scaled by *Transaction Value*) and *Incremental Fraction* is positive and significant, at about 45%. This implies that *$Innovations* do not fully explain the characteristics of incremental innovations. Lastly, the correlation between the *radical* part and all innovations is low and economically insignificant. I also include measures related to innovation activity, such as the number of radical patents granted and the total number of patents granted by the target firm during the 20-year period preceding the deal announcement. The relation between *$Innovations* scaled by *Transaction Value* and the number of radical patents granted by the target firm does not show a significant correlation. The lack of significant correlation suggests that relying solely on patent-based metrics does not capture the full scope of innovations generated by the company. Innovations extend beyond patents, indicating that patent-based measures might overlook important aspects of innovation.

By construction, *Radical Fraction* exhibits a positive correlation with the number of radical patents granted by a target firm. However, the correlation between the number of (radical) patents and *Radical Fraction* is only approximately 28% (31%). Correlations between *Incremental Fraction* and the number of patents are low and negative. Approximately 44.6% of target firms granted at least one patent in the 20-year period preceding the deal, while 41.4% of acquiring firms did not publish any patents during the same period. Overall, Table 2 supports the hypotheses that patents imperfectly represent innovations.

I merge the M&A sample with the *CRSP* and *Compustat* datasets, resulting in 1,625

M&A deals involving 1,043 unique acquirers. Summary statistics for accounting and market data are presented in Appendix C, Table C1.

4 Results

In this section, I present my main findings. First, I test the hypotheses concerning acquirers' motives for purchasing various types of innovations. Next, I explore how the technologies acquired through these M&As influence the strategic decisions of the merged entity, particularly in terms of innovation performance and the adoption of acquired technologies.

4.1 Determinants of innovation acquisition

To test the hypotheses on the characteristics of acquirers that can predetermine the purchase of innovations before the deal, I conduct a Tobit model analysis[12]. Results are presented in Table 3. The analysis distinguishes between firms acquiring *incremental* innovations and those acquiring *radical* innovations. The sample consists of 1,393 US public-to-public M&A deals between 2001 and 2021. The independent variables are various acquired innovations identified in PPA files. The dependent variable in column (1), *Innovations/VT*, is the total dollar value of innovations scaled by the value of transaction. The second dependent variable is the fraction of radical innovations, calculated as the dollar value of radical innovations divided by the total value of innovations. The third variable is the fraction of incremental innovations, calculated as the dollar value of incremental innovations divided by the total value of innovations. The main independent variables represent acquirer characteristics one year before the deal announcement. Following prior studies (see e.g., Moeller et al., 2004; Cai and Sevilir, 2012; Bena and Li, 2014;

[12]Tobin (1958) proposed the Tobit model for scenarios where the dependent variable faces a distinct constraint, leading observations to cluster at the boundary of this constraint condition.

Gokkaya et al., 2023), I include additional acquirer characteristics, deal characteristics and target-specific characteristics as control variables.

In Section 2, I hypothesize that acquirer firms placing greater importance on scale effects and international market expansion are more inclined to purchase innovations, particularly prioritizing radical ones. To test my hypotheses, I use *Foreign Income* normalized to total assets as a proxy of network and scale effects and the propensity for market expansion. Table 3 shows that the most substantial and statistically significant positive coefficient for *Foreign Income* pertains to the purchased *Radical Fraction.* While *Foreign Income* exerts a notable and statistically significant positive influence on the likelihood of purchasing both *Innovations* and *Radical Fraction*, the impact is nearly twice as for the radical component. While the sign of estimated coefficients in a Tobit model is reliable, their economic magnitude is complex due to non-linearity. To interpret these coefficients, in Table 3, I use the average partial effect (APE)[13]. Specifically, a one standard deviation increase in *Foreign Income* is associated with a 0.025 rise in the target's *Radical Fraction*, which accounts for approximately 20% of the unconditional mean of *Radical Fraction.* This positive correlation underscores the advantage of the non-rivalrous nature of *radical* innovations for companies leveraging scale effects. *Radical* technologies can be extensively deployed within such companies, and the larger their network, the more valuable these technologies become. However, while this effect holds significance both economically and statistically for *radical* innovations, it lacks significance for *incremental* technologies, as shown in column (3). The lack of effect on *incremental* technology acquisitions is the result of their non-excludability nature. *Incremental* innovations are more easily replicable, rendering it unnecessary for corporations to acquire entire companies to access them.

The size of the acquirer itself, *ln(MV)*, does not emerge as a significant determinant of

[13]I follow the approach outlined in Wooldridge (2005), to interpret the coefficients. Table 3 presents APE coefficients and p-values clustered at the industry level.

technology acquisition. This lack of effect may stem from some large firms becoming excessively complex and bureaucratic, thereby impeding their ability to innovate efficiently and prompting them to pursue partnerships rather than M&As.

In Section 2, I posit that companies engaged in high levels of innovation activity are more inclined to acquire firms that also exhibit a high level of innovativeness, particularly those involving *radical* innovations, due to the necessity of understanding complex business models. I do not observe the dollar value of innovations produced by the acquirer. Therefore, rather than directly measuring the dollar value of innovations produced by acquirers, I use proxies such as *R&D expenditures* and the presence of radical innovations, determined by the dollar value of highly cited patents over the 20 years preceding the acquisition announcement scaled by total assets the year prior to the announcement, *Radical Inn./Total Assets*.

Table 3, column (2) indicates that as the acquirer's level of radical innovations scaled by total assets, *Radical Inn./Total Assets*, increases, there is a greater probability of acquiring targets with significant radical innovation activity. Although the economic impact shown in column (2) may seem modest, it is important to consider that the metric for the acquirer's radical innovation is normalized by total assets, with a mean of 0.34 and a standard deviation of approximately 1.01. This implies that a one standard deviation increase in the acquirer's radical innovation results in a 1.4% increase in the acquired radical fraction. The impact of the acquirers' radical technologies on the dollar value of all purchased innovations and only incremental innovations is shown in columns (1) and (3). While the effect of the acquirer's radical innovations on all purchased innovations is statistically insignificant, the effect on the incremental fraction is negative and significant at the 10% level. These findings imply that companies are more inclined to acquire radical innovations when they already have a grasp of them and comprehend their linked business models.

To complement patent-based measures of innovation activity in acquirer firms, I include R&D expenditures as an additional proxy of R&D activity, represented by *R&D exp./Total Assets*. While R&D expenditures may not fully capture innovation output, they provide valuable insights into an acquirer company's business model and focus. The effect of acquirer R&D expenditures on targeting radical technologies is positive for all types of innovation, but it is significant only for radical fractions, as shown in column (2). A 1% increase in acquirer R&D expenditures corresponds to a 0.41% rise in the purchased *Radical Fraction*. These findings underscore that the level of R&D expenditures within the acquiring company is a crucial factor in purchasing innovations, particularly for radical ones. Importantly, the inclusion of industry-fixed effects allows me to assert that this trend is not confined to industries with low innovation levels, this pattern holds true within industries as well.

These results, which show positive coefficients on R&D expenditures and radical innovations for purchased technologies strongly support my hypotheses from Section 2. In Section 2, I argue that while the impact of an acquirer's radical innovations on purchased technology is multifaceted, understanding both the business model and the purchased technology is more crucial than the desire and ability to rejuvenate the firm with more complex technologies. Radical innovations are perceived as the most complicated. For companies with low R&D expenditures and patent activity, the potential for rejuvenating the firm through acquisitions is limited, as evidenced by their minimal probability of acquiring high-technology firms.

The latter part of the hypotheses in Section 2 predicts the relationship between cash reserves, debt level and different types of acquired innovations. I propose that cash-rich acquirers are more likely to pursue incremental innovations, and that cash reserves are less important when acquiring radical innovations. This hypothesis finds support in Table 3. The table illustrates that while operating cash scaled by total assets is insignificant and economically small for both *\$Innovations/VT* and *Radical Fraction* in columns (1) and (2), it emerges as economically and statistically significant solely for *Incremental Fraction* in column (3). This result can be explained by the difference in protection mechanisms between radical and incremental innovations. Radically innovative technologies often come with patents, which not only protect intellectual property but also reduce information asymmetry for external parties. In contrast, incremental innovations may lack robust protection mechanisms, thereby intensifying concerns related to information asymmetry. Specifically, a one standard deviation increase in *Cash* to total assets boosts the target's *Incremental Fraction* by 0.031, which is 9.96% of the unconditional mean. This finding is statistically significant at the 10% level. An additional explanation for this finding is that incremental innovations are often easier to implement and more closely related to existing products than radical innovations. Consequently, acquirers planning to quickly integrate purchased technologies need significant and immediate investments. Therefore, having readily available cash is crucial for rapidly incorporating new technology into production.

Conversely, the negative coefficient associated with debt in columns (1) to (3) indicates significant information asymmetries and risk levels in innovation acquisitions. This suggests that shareholders or the acquirer's management teams are hesitant to increase the company's risk exposure during M&A transactions. To maintain a relatively consistent risk profile, even compared to peers involved in M&A deals without substantial innovation purchases, there is a tendency to keep lower levels of debt and higher levels of cash in the capital structure before the deal announcement.

The additional control variables in Table 3 highlight the acquirer characteristics relevant to the strategic choice of purchasing different types of innovations. The first set includes accounting variables from acquirer firms one year prior to the deal announcement, as well as the number of acquisitions completed by the acquirer in the ten years preceding the current deal. The next set of control variables includes accounting characteristics of the target firms one year prior to the deal announcement. These characteristics, such as *ln(Age)*, *R&D expenditures*, and *market-to-book ratio*, are unrelated to the decision of purchasing innovations, but might be highly correlated with the innovation outcomes of the target firm and could potentially bias estimations. The ratio between market and book values is positively correlated with all innovations, particularly with the *incremental* part. This suggests that the market actually recognizes some incremental technologies before the deal, as reflected in the market value relative to the book value. The target's *R&D expenditures* are expected to be positively correlated with all types of innovations, as shown in columns (1) to (3). However, it is important to note that *R&D expenditures* do not fully determine the innovation outcomes of the target firm as recognized by the acquirer.

The final set of control variables includes *ln(Value of Transaction)* and *Diversifying.* The *Diversifying* variable is an indicator, set to one if the acquirer and target are assigned to different industries based on the 3-digit SIC code, and zero otherwise. Lastly, all specifications contain industry and year-fixed effects.

Additional deal-level controls, including indicators for transactions fully completed with cash, those conducted as tender offers, and the count of bidders prior to deal completion, are incorporated in Table 4 Appendix C. These additional controls reveal robust results because the main variables maintain their economical and statistical significance. Notably, even in cases where the deal was fully completed with cash, the ratio of cash to total assets of the acquirer measured one year before the deal announcement remains positive and significant for the acquisition of incremental technologies. This suggests that cash is not merely a means of preparing to pay off the deal.

My findings are also robust across different econometric specifications. In Appendix C, Table C2 I employ in columns (1) to (3) a pseudo-Poisson model, suitable for any dependent variable with nonnegative values without the need to specify its distribution explicitly (see, e.g., Gourieroux et al., 1984). In columns (4) and (5), I utilize fractional quasi-likelihood estimation methods for regression models with a fractional dependent variable (see, e.g., Papke and Wooldridge, 1996). The fractional quasi-likelihood regression does not apply to innovations scaled by transaction value, *Innovations/VT*, since it is not bounded between 0 and 1. In cases where liabilities are high, the dollar value of innovations may exceed the transaction value, making fractional analysis unsuitable in this context. Although the estimated results may differ in economic magnitude, their interpretation also diverges from that of the Tobit model, potentially leading to disparities in particular estimations. Nevertheless, the signs of the estimated coefficients and their statistical significance are the same across models.

It is important to clarify that the cross-sectional Tobit model I use does not imply any causal relations. Acquirer firms do not randomly select target firms, instead, their choices are deliberate, guided by motivations and strategic considerations. Therefore, the pre-merger characteristics of the acquirer firm can act as both motivations for acquiring a specific company and preparation for targeting a particular entity.

In summary, these findings support the hypotheses that radical innovations are more valuable for firms relying on scale or network effects, radical innovations of an acquirer predict innovation purchase, and the necessity of cash when targeting incremental innovations. Additionally, they underscore the notion that companies tend to purchase innovations aligned with their understanding of the business model, particularly in terms of innovation strategies.

4.2 Radical innovation performance of the newly formed entity

In this section, I examine how acquired innovations impact the innovation performance of newly formed entities. Since the market value of innovations produced by new entities is unavailable, I focus on the *radical* part of innovation output. The radical innovation activity of a joint entity is measured over a 3-year period after the deal, scaled by the total assets one year post-transaction. Specifically, the dependent variable is *Radical Innovations*$^{New\ Entity}$, calculated as described in equation (A3). Table 5 presents results from both Tobit models and cross-sectional regression analyses based on the sample of 1,089 M&A deals between public US companies from 2001 to 2020. I excluded deals occurring after 2020 to observe the complete three-year window and to assess the long-term effects on innovation.

The key independent variables in Table 5 are *$Innovations/VT*, as well as the proportions of radical, *Radical Fraction*, and incremental, *Incremental Fraction*, innovations purchased in the transaction. Since the dependent variable *Radical Innovations*$^{New\ Entity}$ is highly skewed due to the nature of radical innovation output, I apply both Tobit and OLS regressions. Table 5 columns (1), (2), and (3) show Tobit specifications in terms of average partial effects (APE) to aid the interpretation of the coefficients of the non-linear model. I use the Tobit model because, similar to the previous section, the negative performance of radical innovation activities is not observable. Columns (4), (5), and (6) present the cross-sectional regression analysis.

I include several sets of control variables in Table 5. These controls encompass the accounting characteristics of the new entity one year after deal completion, as well as the characteristics of the acquirer and target firms before deal announcement that might influence the radical innovation performance of the newly formed entity. Additionally, I include deal characteristics that could be important for the innovation success of the new entity.

The key finding in Table 5 is that while the level of innovations, *$Innovations/VT* in columns (1) and (4), and proportion of incremental innovations, *Incremental Fraction* in columns (3) and (6), do not significantly correlate with the radical activity of the combined entity, the *Radical Fraction* exhibits a significant and positive correlation with radical innovations of the new entity, as shown in columns (2) and (5). This finding supports the hypothesis that acquired radical innovation exhibits a positive correlation with subsequent radical innovation performance. Furthermore, it aligns with the findings of Sevilir and Tian (2012), which indicate that M&A activities tend to have a positive impact on the innovation outcomes of acquirer firms, especially if the target firms are innovative prior to the merger. My analysis reveals that a 1% increase in the acquired radical fraction corresponds to a notable 0.2% increase in the proportion of the value of radical patents relative to total assets, which is 1.53% of the unconditional mean, as shown in column (2). Moreover, these findings also underscore the tendency for acquirers to uphold or even reinforce targets' existing business structures concerning research and development activities, rather than destroy them. The absence of an impact from the *Incremental Fraction* suggests that the purchase of incremental innovations does not necessarily yield breakthrough innovation outcomes within the span of several years. When an acquiring entity chooses to adopt incremental technology, it may lean more towards integrating these technologies into its current operations rather than fostering the emergence of novel, cutting-edge technologies.

The significance of the *Radical Fraction* persists even after controlling for the radical innovations already present within the acquirer company prior to the M&A transaction, *Radical Inn./Total Assets* in the set of $Acquirer_{t-1}$. *Radical Inn./Total Assets* is *radical* performance of the acquirer company over the 20-year period leading up to the deal, as measured by the dollar value of highly cited patents relative to total assets. This variable exhibits a significant positive correlation with the radical innovations of the combined entity, $Radical\ Innovations^{New\ Entity}$, across all specifications. This means that the legacy of the acquiring company significantly predetermines the future radical innovation performance of the newly formed entity.

These results lend support to my hypothesis that acquired radical innovation correlates positively with subsequent radical innovation performance. It underscores the importance of maintaining an innovation framework rather than undermining it and highlights the significance of comprehending purchased technology. Overall, companies tend to purchase innovation-oriented businesses if they understand them well, and I find that they also tend to continue with the same type of innovations in the future.

The analysis also reveals that a significant amount of debt relative to total assets and high levels of cost of goods sold (further, COGS) of the new entity are negatively correlated with the dollar value of radical patents granted to the new entity. These findings imply that firms' indebtedness, which can be perceived as a financial constraint, hampers breakthrough patenting activity, possibly due to the risks inherent in radical innovation endeavors. Company management may be less willing to invest in radical activities when burdened by high levels of debt compared to industry peers. Moreover, the negative correlation with COGS suggests that less innovative companies may be associated with higher costs of production.

Additionally, I employ a pseudo-Poisson model suitable for any dependent variable with non-negative values without distribution specification, as detailed in Appendix C, Table C3. The main variables of interest in this analysis are innovations scaled by the value of transactions, and the fractions of radical and incremental innovations. Table C3 shows that the coefficient for the *Radical Fraction* is positive and statistically significant, as it is in Table 5. However, the effect of the *Radical Fraction* in column (2) of Table C3 is twice as large as in column (2) of Table 5. The independent variables, such as innovations and incremental fractions, are statistically insignificant, similar to the results in Table 5. Additionally, the coefficient for acquirers' radical innovations, *Radical Inn./Total Assets*, remains positive and economically significant with the same magnitude. Regarding the rest of the independent variables, while the statistical significance is consistent, differences in the economic magnitudes of coefficients between the APE Tobit, OLS, and Poisson models can be attributed to their distinct methodologies and interpretations of results.

As an additional robustness test, I substitute the acquirers' radical innovation performance, *Radical Inn./Total Assets*, with all patents produced by the acquirer, as shown in Table C4. Specifically, I calculate the dollar value of all patents produced by the acquirer during the 20-year window before the M&A, using a linear decay, *$Patents*, and scale this by the total assets of the acquirer one year before the announcement, *$Patents/Total Assets*. All findings remain robust.

In summary, target firms with radical innovations appear to support and potentially enhance the patent performance of the newly formed entity. Additionally, the past success of the acquirer firm in producing radical innovations significantly influences the radical innovation performance of the joint entity. Acquirer companies tend to target firms whose innovation or business strategies they understand, and they effectively maintain or leverage the innovative strategies of their targets.

4.3 Adoption of acquired technology

The final part of my analysis focuses on demonstrating the hypothesized synergy effect of integrating acquired technology into the newly formed entity. Essentially, this synergy effect is realized through the efficient adoption of acquired technology, which reflects in either expanded market presence or reduced costs.

To test hypotheses concerning how the new entity incorporates acquired innovations, I conduct a cross-sectional regression analysis as shown in Tables 6 and 7. I test whether the effective adoption of acquired technology leads to either market expansion or cost reduction. To test the former, I use sales growth as a proxy of market expansion due to the adoption of acquired innovations as in Table 6. To assess the effect on cost reduction, I employ the ratio of costs of goods sold to total sales as in Table 7.

The regressions shown in Table 6 are estimated based on data from 1,030 US public-to-public deal observations from 2001 to 2020. I drop all observations after 2020 to assess the performance during the 3-year window after deal completion. The dependent variable is sales growth, as defined by equation (A4), which is the yearly change in sales adjusted by lagged total sales one-year following deal completion. Regarding the control variables, in addition to factors related to the new entity, acquirer, target, and deal characteristics outlined in Table 5, I incorporate the variable artificial sales growth, $\Delta Sales^{a,t}_{t-1,t-2}$, as described by equation (A5), into the regressions. This variable is the hypothetical one-year sales growth of the target and acquirer firms if they had been a combined entity before the deal announcement. The introduction of this additional control variable serves to mitigate any potential bias stemming from predetermined sales trends.

In Section 2, I conjecture that the effective integration of acquired innovations leads to an expanded market presence. Column (1) of Table 6 shows results from an OLS regression with the acquired dollar value of innovations scaled by the total transaction value as the key independent variable. I find that the higher the value of acquired innovations, the larger the sales growth of the combined entity. Therefore, a higher value of acquired innovations has a strong connection with future market expansion. I continue to find strong support for the importance of purchased technology as a determinant of sales growth in columns (2) and (3). Columns (2) and (3) include additional important control variables such as *Radical Fraction* and *Incremental Fraction*. The coefficients associated with *Innovations/VT* remain positive and statistically significant. Specifically, a one standard deviation (0.38) increase in *Innovations/VT* corresponds to an average increase in sales growth of 0.16, which is approximately twice the average sales growth rate of 0.07. This indicates that purchased innovations significantly positively correlate with future sales dynamics. Furthermore, my analysis reveals a positive correlation between the sales growth of the combined entity and the ratio of purchased radical innovation, as evidenced in column (2). In contrast, the impact of the purchased incremental fraction, while positive, is statistically insignificant. As I expected, the overall value of purchased technology outweighs the significance of specific types, be it radical or incremental.

The effective integration of acquired innovations can result in not only an expanded market presence but also in cost reduction. I test this hypothesis in Table 7, which presents the results from cross-sectional regressions of the determinants of the costs of goods sold scaled by total sales in the year following deal completion, as defined by equation (A6). The explanatory variables used are the same as those in Table 6.

Column (1) of Table 7 shows that the coefficient on *Innovations/VT* is positive and economically significant at the 10% level. This positive coefficient is also observed in columns (2) and (3). These findings show that COGS scaled by sales increase with the adoption of purchased technologies. Contrary to the expectation that acquired innovations might lead to cost reductions, the data shows that costs actually increase within a one-year horizon. The same trend is observed for *Radical Fraction*, with the coefficient in column (2) being positive and significant at the 10% level. I propose two potential explanations. First, the business structure of the target firm could be an important factor. Firms with intensive R&D activities often have a unique communication structure and distinct employee incentives. Integrating such a firm into a larger entity may lead to increased costs due to a more complex bureaucratic structure or changes in the incentives of key employees, as suggested by Fulghieri and Sevilir (2011). Second, the effective adoption of radical innovation, which could eventually lead to cost reduction, may be challenging and may not yield significant benefits within one year on average.

In contrast, column (3) shows that acquired incremental technologies contribute to a reduction in the costs of goods sold. Although the coefficient may appear modest, considering that the mean of the $Costs_{t+1}$ ratio is 0.002 with a standard deviation of 0.012, a one standard deviation (0.46) increase in the *Incremental Fraction* leads to an 18% decrease in the mean of costs to sales ratio.

My results support the proposed hypothesis that the acquisition of incremental innovation leads to a decrease in the cost of goods sold. Since incremental technologies are less complex and closely aligned with the final product, they are easier to adopt and integrate into the production process.

5 Conclusion

Over the past few decades, companies have increasingly relied on innovations to drive economic growth and market expansion. One effective strategy for accelerating innovation activities is to acquire a company with a strong track record of innovation. In my paper, I focus on M&A deals to identify the factors that drive the purchases of innovations and the resulting effects. Within the M&A context, acquirers may pursue radical innovations, focus on incremental innovations, or engage in deals unrelated to innovation. In my paper: 1) I develop measures of innovation using hand-collected purchase price allocation data from M&A deals, 2) I identify characteristics of acquirers who purchase either radical or incremental innovations. Companies that rely on economies of scale tend to buy radical innovations, while cash-rich acquirers often purchase incremental innovations. 3) I analyze the ability to adopt acquired innovations. I demonstrate that acquiring innovations positively affects marginal sales, with radical innovations significantly boosting patent activity and incremental innovations leading to cost reductions.

Despite the growing importance of intangible assets in the 21st century, accounting rules still classify R&D expenditures as expenses rather than investments, obscuring the true dollar value of the innovations produced. Using a newly developed, manually collected database, I constructed measures to differentiate between radical and incremental innovations in target firms involved in U.S. public-to-public M&A transactions from 2001 to 2021. On average, the dollar value of purchased innovations accounts for 16% of the purchase price, with some deals exceeding 100%. Incremental innovations make up an average of 41% of total purchased innovations. My unique measures of the dollar value of radical and incremental innovation activities reveal aspects of R&D activity not captured by patent data, highlighting the limitations of relying solely on patent-based measures to gauge innovation activity.

The paper has two main findings. I find that companies with substantial cash reserves and low capital expenditures tend to acquire target firms with a larger fraction of *incremental* innovations. On the other hand, companies that rely on scale or network effects, have high R&D expenditures, and possess a significant dollar value of previously granted patents are more likely to acquire target firms characterized by *radical* innovations. I posit that while *incremental* innovations are often less recognizable, resulting in greater information asymmetry during transactions necessitating cash, *radical* innovations hold more value for companies relying on scale and scope effects due to their non-excludability. Companies that depend on economies of scale, have a track record of producing radical innovations and have less relative debt are more likely to acquire innovative companies, irrespective of the type of innovation.

The second set of results relates to the joint entity's performance. The total purchased innovations do not significantly influence the *radical* activity of the future entity. However, the acquisition of *radical* technology predicts a higher dollar value of granted patents for the joint entity, surpassing the impact of previous patents issued by the acquirer alone. My finding supports the hypothesis that acquirers tend to target companies with business models similar to their own, making them more understandable and thus more attractive for acquisition.

The individual impact of *incremental* and *radical* technologies purchased by the joint entity on sales growth is insignificant. However, when considering all purchased innovations collectively, their impact becomes positive and economically significant. It suggests that the joint entity can effectively incorporate purchased technologies, resulting in increased sales growth. My finding supports the idea of complementary innovations, emphasizing the ability to effectively integrate purchased technologies. Consequently, it provides a new perspective on the synergy effects achieved by companies through M&A transactions, which has not been explored in the empirical literature before. Lastly, the purchased *incremental* technologies reduce the relative cost of goods sold within a one-year window. The finding supports the hypothesis that acquirers can effectively adopt incremental innovations to lower their production costs, providing tangible benefits to the acquirers.

Overall, the paper provides new empirical insights into the complex dynamics of innovation in M&A transactions, highlighting the importance of understanding different innovation types to fully comprehend their impact on firm performance and the realization of synergies

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Figures

Figure 1: Measures of innovation activity

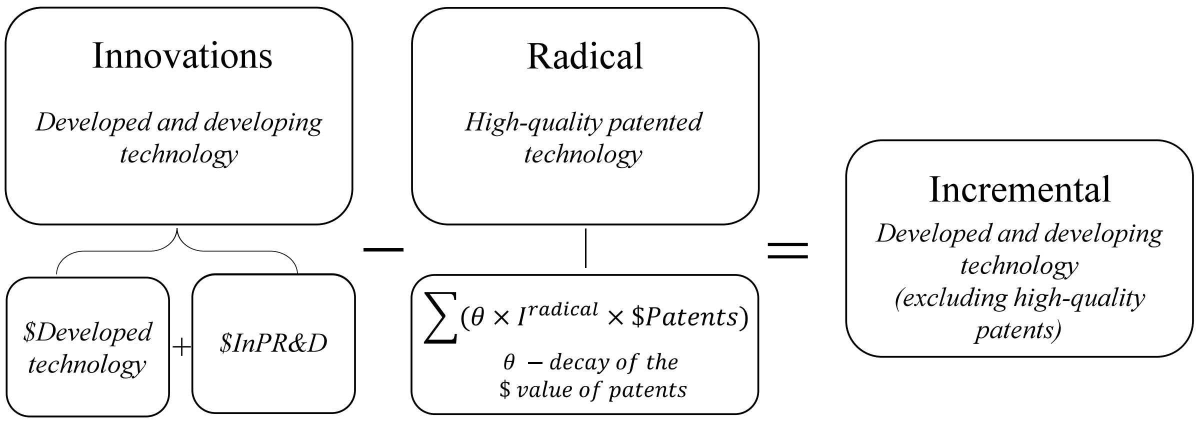
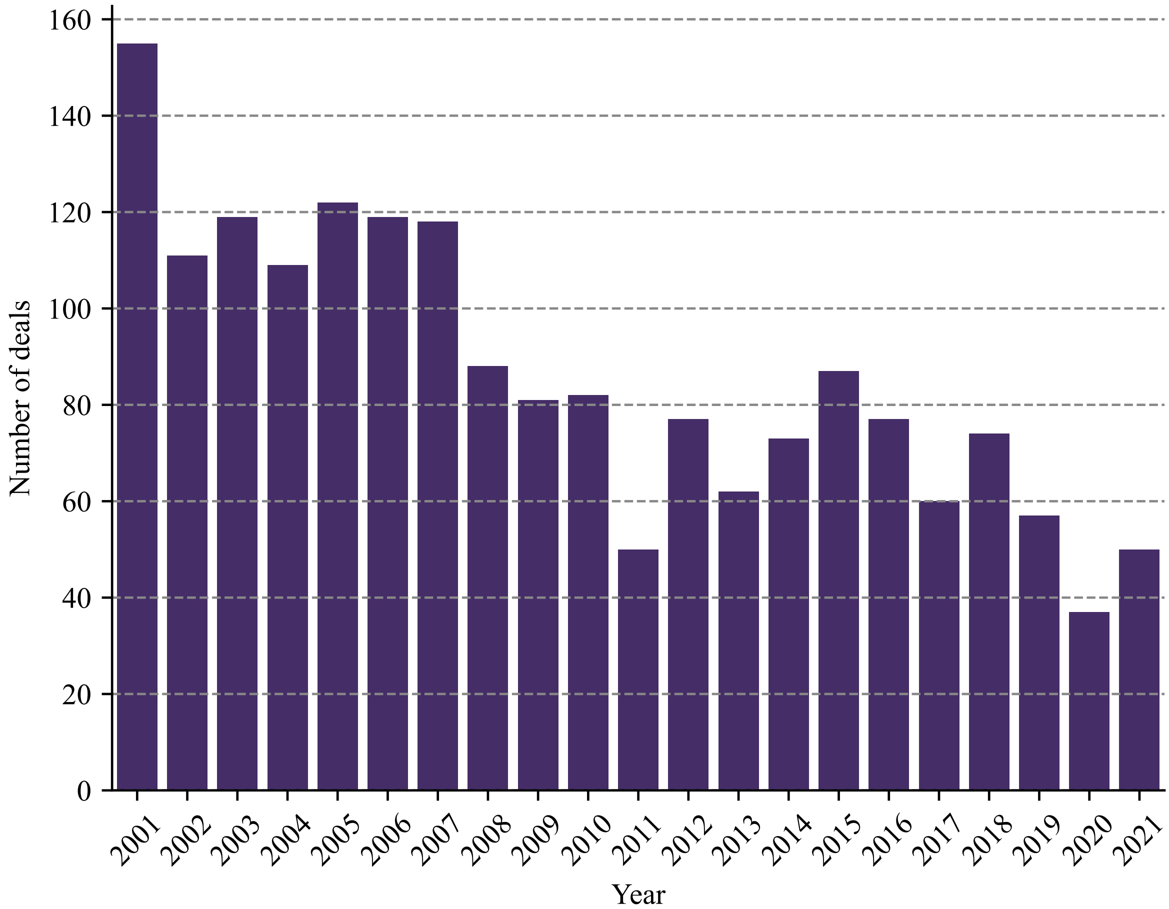


Figure 2: Yearly Trends in Public-to-Public US M&A Deals

The figure shows yearly trends in the number of deals, based on data from 1,796 public-to-public M&A deals in the U.S., involving 1,171 acquirers, covering the period from 2001 to 2021. The data is sourced from the SDC Platinum database.



Tables

Table 1: Summary statistics on Purchase Price Allocation files

The table presents summary statistics on intangible assets and aggregate purchase prices realized after the M&A deal completion reported by acquiring companies. The sample contains 1,796 public-to-public US M&A deals with a transaction value of more than $1 million. The data is derived from the 10-K(Q) files and covers the period from 2001 Q3 to 2021 Q4. During the parsing procedure, some data of poor quality were excluded from the sample. *Goodwill* is not included in the calculation of total intangibles. Data are from the SDC Platinum and 10-K(Q) SEC files. Appendix D contains detailed variable definitions.

	Obs	Mean	Std	25th Pct.	Median	75th Pct.	Min	Max
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Aggregate Purchase Price ($mln)	1,584	2,711.1	7,510.8	119.7	525.3	1,991.5	0.79	80,269
Total Intangibles ($mln)	1,530	1,242.9	5,007.6	14.7	107	541.5	-7.9	69,080
Innovations ($mln)	1,410	503.6	3,501.7	0	0	4.1	80.1	69,080
IPR&D ($mln)	1,474	148.8	1,030.8	0	0	2.6	0	19,500
Developed Technology ($mln)	1,418	270.2	2,382.3	0	0	34	0	67,330
Developed Rights ($mln)	1,435	78.1	1,492	0	0	0	0	44,500
Rights & Licenses ($mln)	1,440	162.2	2,016.8	0	0	0	0	54,085
Patent ($mln)	1,426	4.8	52.7	0	0	0	0	1,495
Trademark ($mln)	1,400	186.3	1,309.3	0	0	16.9	0	27,443
Other Intangibles ($mln)	1,403	483.8	2,186.4	0	21	178.6	0	39,146
Goodwill ($mln)	1,546	1,397.6	4,053.8	29.1	202.7	932.3	-12.1	49,085

Table 2: Summary statistics on main innovation measures

The table shows summary statistics and pairwise correlations on the main innovation measures. The sample consists of 1,415 public-to-public US M&A deals from Q3 2001 to Q4 2021. Panel A shows summary statistics on the main innovation measures. Panel B shows the correlation matrix between innovation measures and the number of (radical) patents granted to target firms for the same sample. Statistical significance at the 1, 5, and 10 percent significance level is denoted by ***, **, and *, respectively. Data are from the SDC, USPTO, KPSS, and PPA databases. Appendix D contains detailed variable definitions.

Panel A: Main statistics

	Obs.	Mean	Sd	Median
	(1)	(2)	(3)	(4)
Incremental Innovations ($ mil)	1,415	374.22	2872.99	0
Radical Innovations ($ mil)	1,415	374.68	2599.04	0
Incremental Fraction	1,415	0.41	0.46	0
Radical Fraction	1,415	0.16	0.33	0
$*Innovations/ Value of Trans.*	1,415	0.16	0.34	0.03

Panel B: Correlation between measures

	(1)	(2)	(3)	(4)	(5)
(1) *Incremental Fraction*	1.000				
(2) *Radical Fraction*	-0.255***	1.000			
(3) $*Innovations/ Value of Trans.*	0.449***	0.003	1.000		
(4) # of radical patents$_{target}$	-0.088***	0.307***	0.034	1.000	
(5) # of patents$_{target}$	-0.079***	0.283***	0.040	0.935***	1.000

Table 3: Determinants of purchased innovation types: acquirer characteristics

The table reports results from Tobit regressions (censored on the left side with a threshold of 0) of the determinants of purchased innovations by acquiring companies. The sample consists of a cross-section of 1,393 public-to-public US M&A deals between Q3 2001 and Q4 2021 from the *SDC Platinum* database. *Innovations/VT* equals the dollar value of purchased $\$Innovations$ scaled by *Value of Transaction*. *Radical Fraction* is dollar value of radical innovations scaled by $\$Innovations$, as in equation (3). *Incremental Fraction* is the dollar value of incremental innovations scaled by $\$Innovations$, as in equation (4). Unless otherwise stated, accounting variables are calculated for each acquirer firm one year before the deal announcement. The provided coefficients are APE (average partial effects), $n^{-1}\sum_{i=1}^{n}\Phi(x_i\hat{\beta}\hat{\sigma})$, where $\frac{\partial E(y|x)}{\partial x_j} = \beta\Phi(x\beta/\sigma)$. *Diversifying* is an indicator variable that equals one if the acquirer company and target company are assigned to the different 3-digit SIC industries, and zero otherwise. P-values are shown in parentheses based on standard errors clustered at the industry level. Statistical significance at the 1, 5, and 10 percent level is denoted by ***, **, and *, respectively. Appendix D contains detailed variable definitions.

	Innovations/VT	Radical Fraction	Incremental Fraction
	(1)	(2)	(3)
Cash/Total Assets	0.022	0.007	0.223**
	(0.725)	(0.867)	(0.025)
Debt/Total Assets	-0.051**	-0.069*	-0.098
	(0.038)	(0.086)	(0.140)
COGS/Total Assets	-0.036	-0.025	-0.086
	(0.271)	(0.425)	(0.197)
CAPEX/Total Assets	-0.625*	-0.047	-0.870**
	(0.097)	(0.898)	(0.018)
Loss firm	0.018	0.008	0.008
	(0.459)	(0.618)	(0.747)
Foreign Income/Total Assets	0.244***	0.501***	0.305
	(0.000)	(0.000)	(0.147)
ln(MV)	0.009	-0.010	-0.003
	(0.338)	(0.256)	(0.804)
R&D exp/Total Assets	0.265	0.410***	0.129
	(0.117)	(0.001)	(0.698)
Radical Inn./Total Assets	0.003	0.014***	-0.017**
	(0.390)	(0.008)	(0.040)
Number of Acquisitions	-0.002*	-0.002***	-0.002
	(0.074)	(0.000)	(0.290)

$Target_{t-1}$			
ln(Age)	-0.000	0.003***	-0.004***
	(0.382)	(0.000)	(0.001)
R&D exp/Total Assets	0.178***	0.092	0.153***
	(0.000)	(0.122)	(0.000)
MV/BV	0.004*	0.000	0.009**
	(0.060)	(0.815)	(0.018)
Deal Controls			
ln(Value of Transaction)	0.002	0.037**	0.008
	(0.730)	(0.040)	(0.260)
Diversifying	-0.008	0.023	-0.011
	(0.792)	(0.159)	(0.799)
Fixed effects			
Industry & Year	Yes	Yes	Yes
Observations	1,393	1,393	1,393
Pseudo R2	0.33	0.22	0.17

Table 4: Determinants of purchased innovation types: acquirer characteristics with additional deal-level controls

The table reports results from Tobit regressions (censored on the left side with a threshold of 0) of the determinants of purchased innovations by acquiring companies. The sample consists of a cross-section of 1,393 public-to-public US M&A deals between Q3 2001 and Q4 2021 from the *SDC Platinum* database. This table replicates the analysis presented in Table 3 with additional deal-level controls. The variable *Cash Deal* is set to 1 if the deal was fully implemented using cash, 0 otherwise. *Tender Offer* is set to 1 if the deal was initiated as a tender offer, and 0 otherwise. *Number of Bidders* represents the number of participants involved in the deal. In columns (1)-(3), missing cash data is substituted with 0, in columns (4)-(6), no substitution is made. The provided coefficients are APE (average partial effects). P-values are shown in parentheses based on standard errors clustered at the industry level. Statistical significance at the 1, 5, and 10 percent level is denoted by ***, **, and *, respectively. Appendix D contains detailed variable definitions.

	Innovations/VT	Radical Fraction	Incremental Fraction	Innovations/VT	Radical Fraction	Incremental Fraction
	(1)	(2)	(3)	(4)	(5)	(6)
Cash/Total Assets	0.037	0.020	0.235**	0.005	-0.029	0.364**
	(0.535)	(0.633)	(0.016)	(0.951)	(0.261)	(0.019)
Debt/Total Assets	-0.047*	-0.066*	-0.091	-0.086***	-0.093**	-0.167***
	(0.056)	(0.085)	(0.166)	(0.000)	(0.016)	(0.005)
COGS/Total Assets	-0.040	-0.026	-0.087	-0.021	-0.011	-0.052
	(0.247)	(0.407)	(0.192)	(0.467)	(0.786)	(0.468)
CAPEX/Total Assets	-0.662	-0.153	-0.761*	-0.658*	-0.314	-0.780
	(0.105)	(0.661)	(0.070)	(0.090)	(0.460)	(0.146)
Loss firm	0.020	0.006	0.020	0.022	0.003	0.046
	(0.383)	(0.752)	(0.394)	(0.308)	(0.921)	(0.108)
Foreign Income/Total Assets	0.202***	0.472***	0.244	0.131**	0.552***	0.165
	(0.000)	(0.000)	(0.298)	(0.018)	(0.001)	(0.305)
R&D exp./Total Assets	0.376**	0.466***	0.241	0.742***	0.772***	0.366**
	(0.016)	(0.001)	(0.449)	(0.000)	(0.000)	(0.014)
ln(MV)	0.008	-0.010	-0.010	0.011	-0.017***	-0.017
	(0.424)	(0.342)	(0.537)	(0.247)	(0.000)	(0.304)
Radical Inn./Total Assets	0.004	0.007***	-0.003	0.001	0.005**	-0.002
	(0.277)	(0.000)	(0.478)	(0.652)	(0.011)	(0.806)
Number of Acquisitions	-0.002*	-0.002***	-0.002	-0.002*	-0.002***	-0.001

	(0.078)	(0.000)	(0.256)	(0.067)	(0.000)	(0.499)
Target's Controls						
ln(Age)	-0.000	0.003***	-0.004***	-0.000	0.002*	-0.003**
	(0.379)	(0.000)	(0.001)	(0.696)	(0.054)	(0.033)
R&D exp./Total Assets	0.074***	-0.063*	0.192***	0.016	0.039	0.316
	(0.009)	(0.066)	(0.009)	(0.915)	(0.920)	(0.297)
MV/BV	0.005***	-0.001	0.012*	0.006***	-0.001	0.012
	(0.001)	(0.566)	(0.059)	(0.001)	(0.650)	(0.121)
Deal Controls						
ln(Value of Transaction)	-0.001	0.036*	0.012	0.001	0.041**	0.004
	(0.922)	(0.064)	(0.125)	(0.864)	(0.029)	(0.589)
Diversifying	-0.013	0.020	-0.017	-0.021	0.017	-0.026
	(0.691)	(0.207)	(0.712)	(0.567)	(0.230)	(0.631)
Cash Deal	0.012	0.013	0.055**	0.020**	0.025	0.061**
	(0.187)	(0.493)	(0.049)	(0.011)	(0.271)	(0.013)
Tender offer	0.019	-0.018	0.031	0.015	-0.031	0.042
	(0.335)	(0.517)	(0.377)	(0.489)	(0.297)	(0.300)
Number of Bidders	-0.010	-0.013	-0.057	-0.013	-0.012	-0.069*
	(0.547)	(0.510)	(0.204)	(0.183)	(0.519)	(0.076)
Fixed effects						
Industry&Year	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,386	1,386	1,386	991	991	991

Table 5: Innovation performance: radical innovations of a new entity

The table reports results from cross-sectional regressions of the radical innovation performance of newly formed entities, one year after deal completion. The sample consists of 1,089 public-to-public US M&A deals between Q3 2001 and Q4 2021 from the *SDC Platinum* database. The dependent variable is *Radical Innovations$^{New\ Entity}$*, the radical innovation stock of the newly formed entity over 3 years scaled by *Total Assets* of the new entity one year after deal completion, as in equation (A3). The main independent variables are *Innovations/VT*, *Radical Fraction*, and *Incremental Fraction*. The former is $\$Innovations$ scaled by *Value of Transaction*. *Radical Fraction* (*Incremental Fraction*) equals the dollar value of radical (incremental) innovations scaled by *$Innovations*. Unless otherwise stated, accounting variables are calculated for each newly formed firm one year after the deal completion. Columns (1) to (3) present the APE (average partial effects, $n^{-1}\sum_{i=1}^{n}\Phi(x_i\hat{\beta}\hat{\sigma})$, where $\frac{\partial E(y|x)}{\partial x_j} = \beta\Phi(x\beta/\sigma)$) of Tobit regressions censored on the left side with 0. Columns (4) to (6) show OLS results. Statistical significance at the 1, 5, and 10 percent level is denoted by ***, **, and *, respectively. P-values based on robust standard errors are shown in parentheses below the coefficient estimates. Appendix D contains detailed variable definitions.

Radical Innovations$^{New\ Entity}$	Tobit Model			OLS		
	(1)	(2)	(3)	(4)	(5)	(6)
Innovations/VT	-0.015	0.008	-0.028	-0.024	-0.016	-0.022
	(0.847)	(0.909)	(0.732)	(0.394)	(0.558)	(0.421)
Radical Fraction		0.202***			0.095***	
		(0.000)			(0.008)	
Incremental Fraction			0.030			-0.005
			(0.346)			(0.821)
New Entity$_{t+1}$						
Cash/Total Assets	-0.120	-0.073	-0.133	-0.050	-0.042	-0.049
	(0.205)	(0.423)	(0.146)	(0.685)	(0.727)	(0.690)
Debt/Total Assets	-0.301***	-0.291***	-0.297***	-0.091**	-0.088**	-0.092**
	(0.008)	(0.007)	(0.009)	(0.014)	(0.019)	(0.017)
COGS/Total Assets	-0.076**	-0.069**	-0.072**	-0.024**	-0.023**	-0.024**
	(0.037)	(0.034)	(0.041)	(0.039)	(0.045)	(0.035)
CAPEX/Total Assets	0.567	0.565	0.583	0.463***	0.463***	0.461***
	(0.376)	(0.390)	(0.357)	(0.010)	(0.010)	(0.010)
Loss firm	-0.033	-0.037	-0.034	-0.041**	-0.043**	-0.041**
	(0.576)	(0.524)	(0.576)	(0.026)	(0.017)	(0.025)
Foreign income/Total Assets	0.205	0.043	0.203	0.127	0.052	0.127
	(0.564)	(0.903)	(0.564)	(0.702)	(0.869)	(0.701)

R&D exp/Total Assets	0.466	0.352	0.477	0.290	0.244	0.289
	(0.271)	(0.426)	(0.262)	(0.257)	(0.321)	(0.256)
ln(MV)	0.080*	0.088**	0.080*	0.052**	0.056**	0.052**
	(0.059)	(0.038)	(0.054)	(0.023)	(0.012)	(0.022)
Acquirer$_{t-1}$						
Number of Acquisitions	-0.002*	-0.002**	-0.002*	-0.000	-0.000	-0.000
	(0.057)	(0.049)	(0.058)	(0.655)	(0.755)	(0.657)
ln(MV)	0.029	0.026	0.029	-0.005	-0.007	-0.005
	(0.358)	(0.416)	(0.339)	(0.807)	(0.733)	(0.804)
Radical Inn./Total Assets	0.122***	0.111***	0.123***	0.121***	0.116***	0.121***
	(0.002)	(0.003)	(0.002)	(0.000)	(0.000)	(0.000)
Target$_{t-1}$						
ln(Age)	-0.012	-0.024	-0.010	-0.011	-0.017	-0.012
	(0.347)	(0.107)	(0.456)	(0.276)	(0.124)	(0.277)
MV/BV	0.011***	0.012***	0.011***	0.009*	0.009*	0.009*
	(0.007)	(0.009)	(0.006)	(0.075)	(0.059)	(0.075)
R&D exp/Total Assets	0.151	0.110	0.153	0.047	0.031	0.047
	(0.172)	(0.285)	(0.165)	(0.447)	(0.604)	(0.446)
Deal Controls						
ln(Value of Transaction)	-0.031	-0.043**	-0.031	-0.025**	-0.030***	-0.025**
	(0.129)	(0.017)	(0.137)	(0.012)	(0.003)	(0.011)
Diversifying	-0.017	-0.023	-0.017	-0.023	-0.025	-0.023
	(0.665)	(0.577)	(0.676)	(0.144)	(0.116)	(0.144)
Fixed effects						
Industry & Year	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,089	1,089	1,089	1,089	1,089	1,089
Adj. R2/Pseudo R2	0.39	0.41	0.39	0.30	0.31	0.30

Table 6: Adoption of purchased innovations: sales growth of a new entity

The table reports results from cross-sectional regressions of sales growth determinants of newly formed entities. The sample consists of 1,030 public-to-public US M&A deals between Q3 2001 and Q4 2021 from the *SDC Platinum* database. The dependent variable is $\Delta Sales^{n}_{t+1,t+2}$ as in equation (A4). The independent variables are the same as in Table 5, except for an additional variable, $\Delta Sales^{a,t}_{t-1,t-2}$, which is the sales growth of the artificial firm (the combined entity of the target and acquirer firms before the deal announcement), as per equation (A5). Statistical significance at the 1, 5, and 10 percent level is denoted by ***, **, and *, respectively. P-values based on clustered industry-level standard errors are shown in parentheses below the coefficient estimates. Appendix D contains detailed variable definitions.

	$\Delta Sales^{n}_{t+1,t+2}$		
	(1)	(2)	(3)
Innovations/VT	0.043***	0.045***	0.036***
	(0.002)	(0.001)	(0.004)
Radical Fraction		0.038**	
		(0.014)	
Incremental Fraction			0.017
			(0.329)
$\Delta Sales^{a,t}_{t-1,t-2}$	-0.010***	-0.011***	-0.010**
	(0.009)	(0.005)	(0.010)
New Entity$_{t+1}$			
Cash/Total Assets	0.013	0.016	0.010
	(0.871)	(0.851)	(0.904)
Debt/Total Assets	-0.023	-0.021	-0.020
	(0.482)	(0.527)	(0.518)
COGS/Total Assets	-0.012	-0.012	-0.011
	(0.508)	(0.503)	(0.549)
CAPEX/Total Assets	0.359**	0.360***	0.366***
	(0.011)	(0.009)	(0.008)
Loss firm	-0.025	-0.026	-0.025
	(0.422)	(0.409)	(0.427)
Foreign income/Total Assets	-0.008	-0.038	-0.010
	(0.982)	(0.916)	(0.976)
R&D exp/Total Assets	-0.229	-0.249	-0.229
	(0.153)	(0.117)	(0.160)

ln(MV)	0.045***	0.047***	0.045***
	(0.001)	(0.001)	(0.001)
Acquirer$_{t+1}$			
Number of Acquisitions	-0.000	-0.000	-0.000
	(0.707)	(0.735)	(0.702)
ln(MV)	-0.040***	-0.041***	-0.040***
	(0.004)	(0.004)	(0.003)
Radical Inn./Total Assets	0.013***	0.011***	0.014***
	(0.840)	(0.652)	(0.878)
Target$_{t-1}$			
ln(Age)	-0.002	-0.004	-0.001
	(0.754)	(0.581)	(0.879)
MV/BV	0.005*	0.005*	0.005*
	(0.081)	(0.073)	(0.098)
Deal			
ln(Value of Transaction)	-0.015*	-0.017**	-0.015*
	(0.080)	(0.040)	(0.085)
Diversifying	-0.018	-0.019	-0.018
	(0.162)	(0.146)	(0.152)
Fixed effects			
Industry& Year	Yes	Yes	Yes
Observations	1,030	1,030	1,030
Adj. R2	0.11	0.11	0.11

Table 7: New Entity: Costs

The table reports results from cross-sectional regressions of the determinants of cost reduction for newly formed entities. The sample consists of 1,030 public-to-public US M&A deals from the *SDC Platinum* database. The dependent variable, $Costs_{t+1}$, is the cost of goods sold scaled by sales one year after deal completion, as in equation (A6). The independent variables are the same as in Table 6, except *COGS* is excluded. Statistical significance at the 1, 5, and 10 percent level is denoted by ***, **, and *, respectively. P-values based on industry-level clustered standard errors are shown in parentheses below the coefficient estimates. Appendix D contains detailed variable definitions.

	$Costs_{t+1}$		
	(1)	(2)	(3)
Innovations/VT	0.001*	0.001	0.001**
	(0.089)	(0.123)	(0.015)
Radical Fraction		0.002*	
		(0.077)	
Incremental Fraction			-0.001***
			(0.000)
$\Delta Sales^{a,t}_{t-1,t-2}$	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)
New Entity$_{t+1}$			
Cash/Total Assets	0.004*	0.004*	0.004*
	(0.098)	(0.088)	(0.083)
Debt/Total Assets	-0.003	-0.003	-0.003*
	(0.106)	(0.107)	(0.095)
CAPEX/Total Assets	-0.006*	-0.006*	-0.006*
	(0.082)	(0.074)	(0.071)
Loss firm	0.002*	0.002*	0.002*
	(0.075)	(0.079)	(0.081)
Foreign income/Total Assets	0.012	0.011	0.012
	(0.208)	(0.242)	(0.205)
R&D exp/Total Assets	0.014	0.013	0.014
	(0.323)	(0.340)	(0.327)
ln(MV)	0.001***	0.001***	0.001***
	(0.006)	(0.005)	(0.006)

Acquirer$_{t-1}$			
Number of Acquisitions	0.000	0.000	0.000
	(0.189)	(0.195)	(0.175)
ln(MV)	-0.002***	-0.002***	-0.002***
	(0.003)	(0.003)	(0.003)
Radical Inn./Total Assets	0.000	0.000	0.000
	(0.122)	(0.168)	(0.208)
Target$_{t-1}$			
ln(Age)	0.000	0.000	0.000
	(0.122)	(0.168)	(0.208)
MV/BV	-0.000	-0.000	-0.000
	(0.423)	(0.397)	(0.497)
Deal			
ln(Value of Transaction)	-0.000*	-0.000**	-0.000**
	(0.053)	(0.025)	(0.046)
Diversifying	-0.000	-0.000	-0.000
	(0.752)	(0.727)	(0.741)
Fixed effects			
Industry& Year	Yes	Yes	Yes
Observations	1,030	1,030	1,030
Adj. R2	0.25	0.25	0.25

Appendix A

A.1 PPA data collection: Implication of SFAS Nos. 141 and 142

The growing importance of intangible assets and the increasing proportion of intangible assets in transactions encourage financial regulators to change and enhance the approach to how goodwill and other intangible assets are reflected in merger and acquisition deals. In 2001 Financial Accounting Standard Board (FASB) issued Statement No. 142 and Statement No. 141[14]. The former requires disclosure of information about goodwill and other intangible assets in the years subsequent to their acquisition that was not previously required. The latter requires all business combinations to be accounted for by a single method — the purchase method. The implementation of the unified method allows for a comparison of the financial results of different entities. In detail, Statement No. 142 obligates to disclose information about the changes in the carrying amount of goodwill from period to period (in the aggregate and by reportable segment), the carrying amount of intangible assets by major intangible asset class for those assets subject to amortization and for those not subject to amortization. SFAS No. 141 was revised in 2007, nevertheless, the identifying and recognizing intangible assets guidance remains the same[15]. Although the regulator provides a unified accounting method to assess intangible assets by supplementing with examples, for instance, Figure A1, the *major intangible classes* are not strictly defined[16].

The statement clearly defines the term - intangible asset, which is used to refer to an

[14] All of the provisions of this Statement shall be applied in fiscal years beginning after December 15, 2001, to all goodwill and other intangible assets recognized in an entity's statement of financial position at the beginning of that fiscal year, regardless of when those previously recognized assets were initially recognized. Early application is permitted for entities with fiscal years beginning after March 15, 2001.

[15] The description of the changes: `https://www.fasb.org/document/blob?fileName=IS0807WW.pdf`

[16] The following links provide further details on the classification of intangible assets and the corresponding accounting measures, `https://www.fasb.org/page/PageContent?pageId=/reference-library/superseded-standards/summary-of-statement-no-142.html&bcpath=tff` and `https://www.fasb.org/page/PageContent?pageId=/reference-library/superseded-standards/summary-of-statement-no-141.html&bcpath=tff`.

Figure A1: Example of the implication of SFAS Nos. 141 and 142

The figure provides an illustrative example based on the official guidance provided by the *FASB*. The *FASB* offers a comprehensive framework for the classification and accounting treatment of intangible assets, outlining the relevant rules, techniques, and procedures. The *FASB*'s guidelines can be accessed in the original documents at the following links: *FASB* Statement No. 142 and *FASB* Statement No. 141.

Illustration 1—Disclosure Requirements in Periods Subsequent to a Business Combination

C2. In accordance with paragraphs 45 and 47, the following disclosures would be made by Theta Company in its December 31, 20X3 financial statements relating to acquired intangible assets and goodwill. Theta Company has two reporting units with goodwill—Technology and Communications—which also are reportable segments.

Note B: Acquired Intangible Assets

	As of December 31, 20X3	
($000s)	Gross Carrying Amount	Accumulated Amortization
Amortized intangible assets		
Trademark	$1,078	$ (66)
Unpatented technology	475	(380)
Other	90	(30)
Total	$1,643	$(476)
Unamortized intangible assets		
Broadcast licenses	$1,400	
Trademark	600	
Total	$2,000	

Aggregate Amortization Expense:

For year ended 12/31/X3 $319

intangible asset other than goodwill. Given this terminology, I keep the term *intangible assets*, which does not comprise goodwill. Importantly, an acquired intangible asset shall be initially recognized and measured based on its fair value. It is worth noticing, the categorization and recognition required by SFAS No. 142 and provided by purchase price disclosure tables in 10-K or 10-Q SEC files are unique. Since companies, even public ones, are not required to disclose and assess separately the major class of their intangible assets and Intellectual Property (IP), the estimates during the M&A process remain the exclusive reliable information regarding the output of the firm's innovation activity. In this case, when acquired assets are intended to adopt in a way that is not its highest and best use, such as a brand name or a research and development assets, shall nevertheless be measured at their fair value. Fair values should be determined by independent advisors during the transaction. At the same time, regulators do not rule out the fact that substantial value may arise from the ability to take advantage of synergies and other benefits that flow from control over another entity. Although SFAS does not provide a unique classification of the major innovation classes, the statement contains a bunch of examples that clearly identify the following classes: in-process R&D, technology, customer lists, patents, licenses, developed rights, and customer relationships.

The lack of unique classification significantly complicates the data processing. Indeed, the manual analysis of the 10-K and 10-Q SEC files containing purchase price allocation data reveals several problems, which makes automatic processing of the files hardly accomplishing in practice. Firstly, the regulator does not determine where and how this data should be reported. In other words, the PPA information may be disclosed in the 10-K files as well as in the 10-Q files the fiscal year after the transaction. The categorization may be presented in the form of a table, footnote, or even inside the text of the file. Lastly, the major acquired intangible asset classes can be named differently. Nevertheless, during manual processing, one can easily define and allocate all intangibles to several major classes.

Through a manual analysis of numerous files, I define 8 major classes of acquired intangibles: *Goodwill*, *In-Process R&D (IPR&D)*, *Developed Technology*, *Developed Rights* (includes developed software, currently marketed products (CMPs), mastheads, product development designs, developed recipes), *Rights and Licenses* (includes domain names, federal communications commission (FCC) licenses, franchises, outlicense & marketed products, gaming licenses), *Trademarks* (includes tradenames, brands, trademarks), *Patents* (rarely recognized separately from developed technology), and *Others Intangibles* (includes supply and customer relationships, other, back-log, non-compete agreements, contingent consideration, concession agreements, certificates of need, medicare certifications, orbital slots, favorable drilling, collaboration agreement contracts, advertiser relationships, publisher relationships, partner relationships, customer relationships, favorable operating leases, leases in place, assembled workforce, contractual relationships, in-force books of business, agency relationships, proprietary programs, physician and hospital agreements, player loyalty programs, mining permits, coal supply agreements, royalty contracts, employer groups, provider networks, trading product lines, open interest, database, content). The value of the intangible assets is provided by independent advisors that insure the fair value of assets.

To conclude, SFAS No. 142 and No. 141 implemented in 2001 allows for assessment and differentiation between different classes of acquired intangible assets. I manually collected and categorized this data by defining the main intangible asset classes, which can be used as proxies for the innovation strategy of the target firm. PPA tables are extremely important since they provide a dollar valuation of the result of innovation activity. It discloses various forms of innovation activity without binding to expenditures or granted patents that may help to lift the veil on the nature of the R&D activity within the firm. Additionally, this data may help to explore various economic and financial issues, which were not answered before due to the lack of information about the value of innovations.

A.2 Radical vs Incremental innovations in M&A setting

The subsequent examples provide additional insights, showcasing diverse scenarios within the context of M&A transactions and intangible asset valuation. Thermo Avago Technologies' acquisition of Broadcom Corp. in 2016 serves as an illustrative case where the *radical* component constitutes more than 90% of all developed technologies. The PPA report for Thermo Avago's acquisition of Broadcom is shown in Table A4. The dollar value assigned to innovations is $9,010 million of *Developed Technology* and $1,950 million of *IPR&D* which gives $10.96 billion in *$Innovations*.

According to records from the USPTO, Broadcom was granted 7,700 patents between its IPO in 1998 and the M&A deal in 2016. Among these, 1,704 patents are identified as *radical*, denoted by $I_j^{radical}$ equals one. The cumulative value of these patents amounts to \$10,084.38 million, leaving \$875.61 million as the value attributed to *\$Incremental* innovations. *\$Incremental* innovations represent less than 8% of the total *\$Innovations*.

Conversely, the final example presents a scenario where the target company lacks any radical innovations, yet the acquirer attributes a substantial portion of its intangible assets to *\$Innovations*. In this case, Computer Assoc Intl Inc. acquired Netegrity Inc. in 2004, with Netegrity having gone public in 1993. Table A5 shows the PPA information for Netegrity, specifying the total value of innovations as \$37 million. The note above the table contains information regarding the importance of software in the acquisition. The target company specialises in software, so I can account for it as *\$Innovations*. USPTO data reveals that Netegrity did not issue any patents between its IPO and the M&A deal. Consequently, the value assigned to *radical* innovations is zero.

Table A1: The acquisition of Silver Spring Networks by Itron

The table shows the PPA data from Itron 10-K SEC filing one fiscal year after the acquisition of Silver Spring Networks. The data include the allocation of current assets, property, plant, and equipment, other long-term assets, identifiable intangible assets, and goodwill. It also details the assumed liabilities and the net assets acquired. The file is available `https://www.sec.gov/Archives/edgar/data/0000780571/000078057119000007/itri10k12312018.htm`.

	(in thousands)
Current Assets	$86,701
Property, plant, and equipment	$27,670
Other long-term assets	$3,866
Identifiable intangible assets:	
Core-developed technology	**$81,900**
Customer contracts and relationships	$134,000
Trademark and trade names	$231
Total identified intangible assets subject to amortization	$226,700
In-process research and development (IPR&D)	**$14,400**
Total identified intangible assets	$241,100
Goodwill	$575,750
Current liabilities	($99,406)
Customer contracts and relationships	($23,900)
Long-term liabilities	($2,565)
Total net assets acquired	$809,216

The purchase price of SSNI was $809.2 million, which is net of $97.8 million of acquired cash and cash equivalents. Of the total consideration $802.5 million was paid in cash. The remaining $6.7 million relates to the fair value of pre-acquisition service for replacement awards of unvested SSNI options and restricted stock unit awards with an Itron equivalent award. We allocated the purchase price to the assets acquired and liabilities assumed based on estimated fair value assessments.

Table A2: Examples of the patents granted to Silver Spring Network between IPO and M&A

The table shows the subset of patents granted by Silver Spring Network between IPO in 2013 and M&A in 2018. Each row presents one patent with *Publication Date, Filling Date*, technical sector of the patent (*CPC section*), number of citations received by the patent until the end of 2022 (*Citations*). ξ^{real} is the fitted real value in dollars 1982 from *KPSS*. *Cites* $q25$, *Cites* $q10$, and *Cites* $q1$ represent the 25th percentile, 10th percentile, and 1th percentile, correspondingly, of the number of citations received by all patents in the industry - *CPC section*, in the year - *Publication Date*. $I^{radical}_{q25}$ represents the indicator of *radicality* of the patent, which is equal to one if *Citations* is larger or equal than *Cites* $q25$. *T-t* is the difference in years between M&A date and *Publication Date*. *inflation* is the inflation between 1982 and M&A date. $V^{t,T}(patent_j)$ is the dollar value of the patent calculated by equation (2).

Publication Date	Filing Date	CPC section	Citations	ξ^{real}	Cites $q25$	Cites $q10$	Cites $q1$	$I^{radical}_{q25}$	$T-t$	inflation	$V^{t,T}(patent_j)$
16.04.13	06.08.10	H	20	5.10	5	14	97	1	5.04	2.57	9.16
31.12.13	22.12.11	H	4	6.54	5	14	97	0	4.33	2.57	0
17.06.14	24.11.10	H	7	2.27	4	10	79	1	3.87	2.57	4.42
17.06.14	06.08.08	H	2	2.27	4	10	79	0	3.87	2.57	0
08.07.14	16.12.11	G	8	4.27	5	15	113	1	3.81	2.57	8.34
29.07.14	20.12.11	H	1	3.56	4	10	79	0	3.76	2.57	0
06.01.15	22.12.11	Y	2	2.15	3	8	42	0	3.32	2.57	0
10.02.15	24.05.07	H	3	2.28	3	8	57	1	3.22	2.57	4.63
24.02.15	15.04.13	Y	2	2.73	3	8	42	0	3.18	2.57	0
24.03.15	31.01.12	B	2	2.61	3	9	34	0	3.10	2.57	0
31.03.15	16.04.13	H	2	2.48	3	8	57	0	3.09	2.57	0
14.07.15	17.11.11	H	2	3.06	3	8	57	0	2.80	2.57	0
27.10.15	28.12.11	H	4	3.39	3	8	57	1	2.51	2.57	7.19
03.11.15	20.10.14	H	1	3.66	3	8	57	0	2.49	2.57	0
19.12.17	02.12.16	G	0	3.38	3	7	45	0	0.36	2.57	0

Table A3: The acquisition of Thoratec Corporation System by St. Jude Medical

The table shows the PPA data from St. Jude Medical 10-K SEC filing one fiscal year after the acquisition of Thoratec Corporation System in October 2015. The data include the allocation of current assets, property, plant, and equipment, other long-term assets, identifiable intangible assets, and goodwill.

	(in millions)
Accounts receivable	$76
Inventories	$150
Other current and noncurrent assets	$44
Property, plant and equipment	$57
Goodwill	$2,142
Intangible assets	$1,490
Accounts payable	($22)
Other current and noncurrent liabilities	($69)
Contingent consideration liabilities	($33)
Total purchase consideration	**$3,287**

The goodwill recorded as a result of the Thoratec acquisition is not deductible for income tax purposes. The goodwill is largely attributable to strategic opportunities for growing the Company's portfolio of products treating heart failure by offering more comprehensive therapy options across the care continuum. Synergies are also expected to arise upon the integration of Thoratec, the benefits of utilizing the existing workforce, technology innovation and cross-selling opportunities. Additionally, IPR&D projects that did not have substance at the acquisition date are not separately identified. IPR&D intangible assets include Thoratec projects for its next generation left ventricular assist device and percutaneous heart pumps, which have not been approved for commercialization in the U.S. We currently expect approvals for U.S. commercialization to occur at various times in 2018 and 2019. In connection with the acquisition of Thoratec, the Company recognized $714 million of indefinite-lived IPR&D intangible assets, $683 million of purchased technology and patent definite-lived intangible assets that have an estimated weighted average useful life of 9.8 years and a $93 million trademark definite-lived intangible asset that has an estimated useful life of 16.0 years.

Table A4: The acquisition of Broadcom Corporation by Thermo Avago Technologies

The table shows the PPA data from Thermo Avago Technologies 10-K SEC filing one fiscal year after the acquisition of Broadcom Corporation. The data include the allocation of identifiable intangible assets, in-process R&D, and the weighted-average amortization periods.

	Fair Value (in millions)	Weighted-Average Amortization Periods (in years)
Developed technology	$9,010	6
Customer contracts and related relationships	$2,703	2
Order backlog	$750	< 1
Trade name	$350	17
Other	$45	16
Total identified finite-lived intangible assets	**$12,858**	
In-process research and development	$1,950	N/A
Total identified intangible assets, net of assets held-for-sale	$14,808	
Intangible assets included in assets held-for-sale	$320	
Identified intangible assets	**$15,128**	

Developed technology relates to products for wired and wireless communication applications. We valued the developed technology using the multi-period excess earnings method under the income approach. This method reflects the present value of the projected cash flows that are expected to be generated by the developed technology less charges representing the contribution of other assets to those cash flows. The economic useful life was determined based on the technology cycle related to each developed technology, as well as the cash flows over the forecast period.

Table A5: The acquisition of Netegrity, Inc. by Computer Associates International, Inc.

Netegrity was a provider of business security software, principally in the areas of identity and access management. The Company has made Netegrity's identity and access management solutions available both as independent products and as integrated components of the Company's eTrust Identity and Access Management Suite. The acquisition cost of Netegrity has been allocated to assets acquired and liabilities assumed based on estimated fair values at the date of acquisition as follows:

	(in millions)
Cash and marketable securities	\$97
Deferred income taxes, net	\$4
Liabilities assumed, net	(\$12)
Purchased software products	\$37
Customer relationships	\$45
Trademarks/tradenames	\$26
Goodwill	\$258
Purchase price	**\$455**

Purchased software products and customer relationships will be amortized over 7 years and 12 years, respectively. The Netegrity acquisition contributed approximately \$32 million of revenue in the second half of fiscal year 2005.

Appendix B

Performance of the Combined Entity: Radical Innovations and Integration of Acquired Technology

In this section, I develop measures to assess the performance of the combined entity, testing hypotheses related to the innovation performance and the synergistic impact of the acquired innovations on the newly formed entity during the one to three-year period following the M&A deal completion.

B.1 Innovations: patent-based measures

To test the hypotheses from Section 2, I need measures of not only the innovation performance of target firms but also the success of the newly formed entity's innovation activities after the merger. The hypotheses concerning the future innovation performance of the combined entity require an assessment of the dollar value of technologies produced by the new entity. However, the dollar value of technology is typically unavailable. Therefore, the only feasible way to assess a portion of these innovations is through the dollar value of highly cited patents. While this approach will primarily cover the *radical* innovations, it remains the best available measure.

I develop a measure, $\$Radical_f^{new\ entity}$, to assess the radical innovation performance of the joint entity, aiming to elaborate on the effect of acquired technologies on innovation outcomes. The newly formed entity lacks data on the market value of its innovations post-deal completion. Consequently, I measure the radical part of innovation through patents, aligning this measurement with that of the target firm. Specifically, I classify a patent as *radical* if it surpasses a predefined citation threshold within its cohort. This threshold is determined based on the percentile of citations received by all patents granted within the same industry and year. Namely, let N_{it} denote the number of citations received by all patents in industry i in year t. Then $N_{it}(p)$ denotes the pth percentile of the industry-year distribution. All patents on the industry-year level, which received more citations than $N_{it}(0.75)$ (or $N_{it}(0.90)$) are classified as *radical*, as demonstrated by equation (1).

The dollar value of patent j granted in year t is measured as follows:

$$V^{t,T}(patent_j^f) = I_j^{radical} \times \xi_j^{real} \times \delta^{T+3}, \tag{A1}$$

where ξ_j^{real} is the fitted real value in 1982 dollars from data provided by Kogan et al. (2017), and the coefficient δ^T adjusts for the inflation between 1982 and the 3-year period after the deal completion, $T+3$. Since I know the dollar value of each patent from the KPSS data, I estimate the dollar value of *radical* innovations produced by the new firm f during the 3-year window after M&A date T, which is equal

$$\$Radical_f^{new\ entity} = \sum_{j=1}^{M_{T,T+3}} V^{t,T}(patent_j^f), \tag{A2}$$

where $M_{T,T+3}$ is the number of patents granted by firm f during the 3-year window after the M&A transaction. When I test my hypotheses, $\$Radical_f^{new\ entity}$ is normalized by the total assets of the joint entity one year after deal completion,

$$Radical\ Innovations^{New\ Entity} = \frac{\$Radical_f^{new\ entity}}{Total\ Assets_{t+1}}, \tag{A3}$$

where $t+1$ indicates one year after deal completion.

Nevertheless, the presented measure covers only the *radical* portion of the innovations produced by the newly formed entity. Therefore, it does not encompass the full range of innovations and the adoption of acquired technologies.

B.2 Innovation adoption: sales growth and cost reduction

The adoption of purchased technologies and the realization of synergy can occur through expanding the market or enhancing the productivity of the newly formed entity beyond the performance of the target and acquirer companies individually. To assess the adaptability of the acquired technology, I use sales growth, which indicates this enhancement in productivity or market expansion within the joint entity.

The sales growth of the new entity is measured as:

$$\Delta Sales^{n}_{t+1,t+j} = \frac{Sales^{n}_{t+j} - Sales^{n}_{t+j}}{Sales^{n}_{t+1}}. \tag{A4}$$

$Sales^{n}_{t+1}$ represents the sales of the newly formed entity in the fiscal year following deal completion, while $Sales^{n}_{t+j}$, $j \in \{2, 3\}$, is the sales of a new entity 2 or 3 years after deal completion.

The issue may arise if the sales growth is predetermined by the previous sales growth of the target and acquiring firms. To account for the company's prior performance and to explore the synergy effect beyond the inherent and predetermined sales growth of both the target and acquirer, I use a benchmark such as the sales growth of an artificial firm. This artificial firm's sales growth represents the anticipated growth had the companies merged prior to the actual deal. The sales growth of the artificial firm is measured as follows:

$$\Delta Sales^{a,t}_{t-1,t-2} = \frac{(Sales^{a}_{t-1} + Sales^{t}_{t-1}) - (Sales^{a}_{t-j} + Sales^{t}_{t-j})}{(Sales^{a}_{t-j} + Sales^{t}_{t-j})}. \tag{A5}$$

In this equation, $Sales^{a(t)}_{t-1}$ is the sales of the acquirer (target) firm the previous fiscal year before the deal announcement and $Sales^{a(t)}_{t-j}$ is the sales of the acquirer (target) firm j, $j \in \{2, 3\}$, years before the deal announcement.

Another channel through which the synergy effect and leveraging of purchased technologies can be observed is cost reduction. To measure changes in costs, I use the cost of goods sold (further, COGS) one year after the deal completion, normalized by sales in the same year:

$$Costs_{t+1} = \frac{COGS_{t+1}}{Sales_{t+1}}, \tag{A6}$$

where $t + 1$ represents the next fiscal year after the deal completion.

The measures presented in this section capture the effect of the deal during the one to three-year period after the M&A. Some may argue that the adoption of technologies might take longer. However, there are two main reasons for considering this period. The first is the rapid pace of technological disruption in the 21st century. Technology can become obsolete in less than a year, making long-term technology enhancement difficult to observe. The second is the fact that successful M&As often lead to future M&As. If the next M&A deal occurs within three years, it becomes challenging to disentangle the effects of the original deal.

The measures presented in this section enable the testing of hypotheses regarding the synergy resulting from the transaction between target and acquirer firms.

Appendix C

C.1 Summary statistics: CRSP and Compustat

I integrate the 1,796 M&A deals sample with the *CRSP* and *Compustat* datasets, the resulting restricted sample consists of 1,625 M&A deals involving 1,043 unique acquirers. The relevant information on deal size and the size of target firms concerning the market value of the acquirer is presented in Table C1 Panel A. Panel B presents accounting variables for both parties, including key statistics one year prior to the deal announcement.

The market value of an acquirer was computed by multiplying the number of outstanding shares by the price one month before the deal announcement, with a similar calculation applied to determine the market value of the target firms. In Panel A of Table C1, it is evident that, on average, the transaction value constitutes 41% (with a median of 18%) of the acquirer company's market value. This emphasizes the substantial impact of the deal, potentially influencing the acquirer's behavior. The ratio between the market value of the target and the acquirer one month before the announcement indicates that, on average, the acquirer company is three times larger than the target firm.

Moving on to Table C1 Panel B, which presents summary statistics based on WRDS data, we observe that acquirers, on average, have total assets of $17.3 billion, while target firms, on average, possess $2.54 billion in total assets. As expected, targets are comparatively smaller in terms of total assets. In terms of cash, targets have higher averages (0.19 with a median of 0.12), compared to acquirers, whose average is 0.13 with a median of 0.09.

Furthermore, targets exhibit lower foreign income than acquirers for non-missing values. The average R&D expenditures for target firms (0.16) are higher than those for acquirers (0.08). In summary, target firms, on average, have higher R&D expenditures and lower foreign income compared to acquirers.

Table C1: Summary statistics on target and acquirer firms

The table presents summary statistics on the market values and accounting data of target and acquirer firms one year before the deal announcements. The sample consists of 1,625 public-to-public US M&A deals valued at more than $1 million each, spanning from Q3 2001 to Q4 2021, involving 1,043 unique acquirers. During the data processing phase, some poor-quality data were excluded, reducing the sample from 1,796 deals in previous tables to 1,625 deals. The data are sourced from the SDC Platinum, CRSP, and WRDS databases. Appendix D contains detailed variable definitions.

Panel A: Market Value

	Obs	Mean	Std	25th Pct.	Median	75th Pct.
	(1)	(2)	(3)	(4)	(5)	(6)
Value of Transaction/market value$_{acquirer_{t-1}}$	1,682	0.41	0.73	0.05	0.18	0.55
Market value$_{target_{t-1}}$/market value$_{acquirer_{t-1}}$	1,452	0.30	0.56	0.03	0.12	0.38

Panel B: Accounting data (1 year before the announcement)

	Acquirer Firms				Target Firms			
	Obs	Mean	Std	Median	Obs	Mean	Std	Median
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Total assets ($bln)	1,600	17.63	44.39	2.78	1,458	2.54	14.49	0.26
Cash/Total assets	1,581	0.13	0.14	0.09	1,451	0.19	0.19	0.12
Debt/Total assets	1,576	0.23	0.26	0.19	1,438	0.22	0.34	0.13
COGS/Total assets	1,598	0.53	0.67	0.32	1,458	0.60	0.67	0.41
CAPEX/Total assets	1,593	0.05	0.06	0.03	1,443	0.05	0.07	0.03
Foreign Inc./Total assets	1,001	0.04	0.06	0.02	599	0.01	0.11	0.01
Goodwill/Total assets	1,475	0.18	0.16	0.14	1,384	0.12	0.16	0.20
Intan. assets/Total assets	1,539	0.26	0.22	0.22	1,405	0.18	0.21	0.09
R&D exp./Total assets	1,070	0.08	0.11	0.05	961	0.16	0.23	0.10
Loss firm	1,600	0.53	0.85	1	1,458	0.07	1	1

C.2 Additional robustness checks

Table C2: Determinants of purchased innovation types: acquirer characteristics. Pseudo-Poisson and fractional ML estimations

The table reports the results from pseudo-Poisson and fractional maximum likelihood estimations of the determinants of purchased innovations by acquiring companies. The analysis replicates Table 3 using different estimation models. Columns (1) to (3) show the results of the determinants of M&A deals based on the pseudo-Poisson estimation. Columns (4) to (6) show the results of the determinants of M&A deals based on the fractional maximum likelihood estimation. P-values are shown in parentheses based on standard errors clustered at the industry level. Statistical significance at the 1, 5, and 10 percent level is denoted by ***, **, and *, respectively. Appendix D provides detailed variable definitions.

	Pseudo-Poisson Model			Fractional Regression	
	Innovations/VT	Radical Frac	Incr. Frac	Radical Frac	Incr. Frac
	(1)	(2)	(3)	(4)	(5)
Cash/Total Assets	-0.156	0.019	0.482*	-0.010	0.687**
	(0.746)	(0.962)	(0.057)	(0.979)	(0.046)
Debt/Total Assets	-0.050	-0.522*	-0.274	-0.394*	-0.276
	(0.856)	(0.096)	(0.165)	(0.057)	(0.256)
COGS/Total Assets	-0.823***	-0.132	-0.381**	-0.052	-0.251*
	(0.001)	(0.430)	(0.023)	(0.723)	(0.073)
CAPEX/Total Assets	-6.594***	-0.726	-2.892**	-0.519	-3.007**
	(0.000)	(0.661)	(0.022)	(0.681)	(0.031)
Loss firm	0.199	0.051	0.005	0.048	0.027
	(0.230)	(0.786)	(0.959)	(0.746)	(0.826)
Foreign Inc/Total Assets	1.023	2.631**	0.742	2.203**	0.807
	(0.254)	(0.013)	(0.276)	(0.042)	(0.373)
R&D exp./Total Assets	1.286*	2.871***	0.379	2.562***	0.670
	(0.057)	(0.000)	(0.447)	(0.000)	(0.287)
ln(MV)	0.144***	-0.108**	-0.001	-0.076	0.001
	(0.001)	(0.010)	(0.976)	(0.129)	(0.978)
Rad. Inn./Total Assets	0.039**	0.030*	-0.014	0.034**	-0.018
	(0.012)	(0.059)	(0.353)	(0.037)	(0.236)
Number of Acq.	-0.025***	-0.009**	-0.008*	-0.008**	-0.007*
	(0.000)	(0.017)	(0.094)	(0.030)	(0.063)

Target$_{t-1}$					
ln(Age)	-0.002	0.012***	-0.013***	0.012***	-0.013***
	(0.503)	(0.001)	(0.000)	(0.000)	(0.000)
R&D exp./Total Assets	0.207	0.016	0.414***	-0.089	0.900
	(0.294)	(0.976)	(0.006)	(0.958)	(0.533)
MV/BV	0.014	-0.011	0.020**	-0.009	0.044
	(0.110)	(0.687)	(0.012)	(0.724)	(0.152)
Deal Controls					
ln(Value of Transaction)	-0.133***	0.296***	0.001	0.211***	0.000
	(0.003)	(0.000)	(0.950)	(0.000)	(0.989)
Diversifying	-0.159	0.184	-0.047	0.135	-0.059
	(0.203)	(0.145)	(0.579)	(0.115)	(0.517)
Fixed effects					
Industry & Year	Yes	Yes	Yes	Yes	Yes
Observations	1,393	1,393	1,393	1,393	1,393
Pseudo R2	0.24	0.16	0.12	0.20	0.20

Table C3: Innovation performance: radical innovations of a new entity. Pseudo-Poisson estimations

The table reports the results from pseudo-Poisson regressions of the radical innovation performance of newly formed entities, one year after deal completion. The analysis replicates Table 5. The dependent variable is *Radical Innovations*$^{New\ Entity}$, the radical innovation stock of the newly formed entity over 3 years scaled by *Total Assets* of the new entity one year after deal completion, as in equation (A3). P-values based on robust standard errors are shown in parentheses below the coefficient estimates. Statistical significance at the 1, 5, and 10 percent level is denoted by ***, **, and *, respectively. Appendix D contains detailed variable definitions.

Radical Innovations$^{New\ Entity}$

	(1)	(2)	(3)
Innovations/VT	-0.206	-0.115	-0.174
	(0.314)	(0.474)	(0.402)
Radical Fraction		0.517***	
		(0.000)	
Incremental Fraction			-0.087
			(0.503)
New Entity$_{t+1}$			
Cash/Total Assets	-0.240	-0.231	-0.208
	(0.197)	(0.167)	(0.321)
Debt/Total Assets	-1.346***	-1.299***	-1.357***
	(0.002)	(0.003)	(0.003)
COGS/Total Assets	-0.608**	-0.604**	-0.635***
	(0.019)	(0.020)	(0.007)
CAPEX/Total Assets	5.022*	4.477*	4.964*
	(0.064)	(0.096)	(0.063)
Loss firm	-0.290	-0.333*	-0.291
	(0.127)	(0.093)	(0.124)
Foreign income/Total Assets	0.443	0.053	0.423
	(0.404)	(0.912)	(0.438)
R&D exp./Total Assets	1.348	1.094	1.303
	(0.462)	(0.516)	(0.471)
ln(MV)	0.353**	0.372**	0.356**
	(0.018)	(0.027)	(0.019)

$Acquirer_{t-1}$			
Number of Acquisitions	-0.005	-0.003	-0.005
	(0.306)	(0.424)	(0.301)
ln(MV)	0.007	-0.015	0.005
	(0.962)	(0.932)	(0.975)
Radical Inn./Total Assets	0.155***	0.138***	0.153***
	(0.000)	(0.000)	(0.000)
$Target_{t-1}$			
ln(Age)	-0.064	-0.093	-0.069
	(0.390)	(0.334)	(0.381)
MV/BV	0.016**	0.016*	0.015**
	(0.012)	(0.057)	(0.019)
R&D exp./Total Assets	0.319	0.330	0.325
	(0.167)	(0.127)	(0.163)
Deal Controls			
ln(Value of Transaction)	-0.111*	-0.142***	-0.114**
	(0.054)	(0.004)	(0.046)
Diversifying	-0.189	-0.220	-0.191
	(0.202)	(0.152)	(0.206)
Fixed effects			
Industry&Year	Yes	Yes	Yes
Observations	1,089	1,089	1,089
Pseudo R2	0.26	0.27	0.26

Table C4: Innovation performance: radical innovations of a new entity with control for the number of patents granted to acquirers

The table reports results from cross-sectional regressions of the radical innovation performance of newly formed entities one year after deal completion. The analysis replicates Table 5 substituting the independent variable *Radical Inn./Total Assets* with *$Patents/Total Assets*. *$Patents/Total Assets* represents the dollar value of all patents granted to an acquiring firm 20 years before the announcement date, with linear decay, scaled by the total assets of the acquirer one year before the announcement. P-values based on robust standard errors are shown in parentheses below the coefficient estimates. Statistical significance at the 1, 5, and 10 percent level is denoted by ***, **, and *, respectively. Appendix D contains detailed variable definitions.

Radical Innovations$^{New\ Entity}$		Tobit Model			OLS	
	(1)	(2)	(3)	(4)	(5)	(6)
Innovations/VT	-0.017	0.009	-0.025	-0.026	-0.016	-0.021
	(0.857)	(0.902)	(0.794)	(0.407)	(0.597)	(0.497)
Radical Fraction		0.225***			0.111***	
		(0.000)			(0.003)	
Incremental Fraction			0.019			-0.013
			(0.570)			(0.599)
New Entity$_{t+1}$						
Cash/Total Assets	-0.032	0.009	-0.040	0.020	0.025	0.023
	(0.750)	(0.924)	(0.687)	(0.877)	(0.843)	(0.855)
Debt/Total Assets	-0.343***	-0.327***	-0.340***	-0.111***	-0.106***	-0.114***
	(0.003)	(0.003)	(0.004)	(0.003)	(0.005)	(0.004)
COGS/Total Assets	-0.089**	-0.081**	-0.087**	-0.031**	-0.030**	-0.032***
	(0.028)	(0.025)	(0.032)	(0.012)	(0.016)	(0.009)
CAPEX/Total Assets	0.534	0.537	0.545	0.454**	0.455**	0.448**
	(0.417)	(0.433)	(0.403)	(0.017)	(0.017)	(0.018)
Loss firm	-0.032	-0.035	-0.032	-0.039**	-0.042**	-0.039**
	(0.575)	(0.525)	(0.574)	(0.036)	(0.024)	(0.035)
Foreign income/Total Assets	0.335	0.153	0.335	0.232	0.145	0.233
	(0.418)	(0.708)	(0.417)	(0.530)	(0.680)	(0.529)
R&D exp./Total Assets	0.295	0.193	0.301	0.152	0.108	0.151
	(0.496)	(0.669)	(0.488)	(0.564)	(0.666)	(0.564)
ln(MV)	0.084*	0.093*	0.084*	0.056**	0.060**	0.056**

	(0.085)	(0.056)	(0.082)	(0.022)	(0.011)	(0.021)
Acquirer$_{t-1}$						
Number of Acquisitions	-0.001	-0.000	-0.001	0.001	0.001	0.001
	(0.734)	(0.818)	(0.732)	(0.255)	(0.206)	(0.253)
ln(MV)	0.024	0.022	0.024	-0.010	-0.011	-0.010
	(0.460)	(0.512)	(0.450)	(0.647)	(0.579)	(0.639)
$Patents/Total Assets	0.036***	0.031***	0.036***	0.036***	0.033***	0.035***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Target$_{t-1}$						
ln(Age)	-0.013	-0.026	-0.012	-0.013	-0.019*	-0.014
	(0.382)	(0.121)	(0.453)	(0.236)	(0.091)	(0.222)
MV/BV	0.012***	0.012***	0.012***	0.009*	0.009*	0.009*
	(0.002)	(0.004)	(0.002)	(0.087)	(0.067)	(0.083)
R&D exp./Total Assets	0.140	0.097	0.142	0.038	0.020	0.038
	(0.199)	(0.346)	(0.196)	(0.537)	(0.736)	(0.534)
Deal Controls						
ln(Value of Transaction)	-0.034	-0.047**	-0.034	-0.027***	-0.033***	-0.027***
	(0.172)	(0.033)	(0.177)	(0.009)	(0.002)	(0.008)
Diversifying	-0.017	-0.023	-0.016	-0.022	-0.025	-0.022
	(0.695)	(0.601)	(0.704)	(0.171)	(0.135)	(0.170)
Fixed effects						
Industry& Year	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,087	1,087	1,087	1,087	1,087	1,087
Adj. R2/Pseudo R2	0.39	0.41	0.38	0.30	0.31	0.30

Appendix D

Variable definitions

This appendix contains detailed definitions of dependent and independent variables used in the analysis. Compustat data mnemonics are in italics within parentheses. Constructed variables are in italics.

Variable name	**Definition**	**Data Source**
Purchase Price Allocation and SDC Platinum:		
Goodwill ($mln)	The fair value of goodwill presented in Purchase Price Allocation (PPA) tables on 10-K/Q SEC files.	SEC
IPR&D ($mln)	The sum of fair values of in-process R&D and engineered drawings presented in PPA tables 10-K/Q SEC files.	SEC
Developed Technology ($mln)	The fair value of developed technology presented in PPA tables on 10-K/Q SEC files.	SEC
Developed Rights ($mln)	The sum of fair values of developed rights, developed software, and currently marketed products (CMPs), mastheads, product development design, and recipes presented in PPA tables on 10-K/Q SEC files.	SEC
Rights & Licenses ($mln)	The sum of fair values of different purchased licenses (for example, Federal Communications Commission (FCC) licenses, gaming), domain names, franchises, outlicenses, marketed products presented in PPA tables on 10-K/Q SEC files.	SEC

Patent ($mln)	The fair value of patents presented in PPA tables on 10-K/Q SEC files.	SEC
Trademark ($mln)	The fair value of trademarks, tradenames, and brands presented in PPA tables on 10-K/Q SEC files.	SEC
Other Intangibles ($mln)	The fair value of everything not included in any category above are presented in PPA tables on 10-K/Q SEC files. All intangible assets classified as groups listed below were categorized as Other Intangibles. Supply, customer, advertiser, publisher, agency, and partner relationships, backlog, non-compete agreements, contingent consideration, concession agreements, certificates of need, medicare certifications, orbital slots, favorable drilling, collaboration agreement contracts, favorable operating leases, leases in place, assembled workforce, employer groups, contractual relationships, in-force books of business, proprietary programs, physician and hospital agreements, player loyalty programs, mining permits, coal supply agreements, royalty contracts, provider networks, trading product lines, databases, content, and others.	SEC
Total intangibles ($mln)	The fair value of total intangibles presented in PPA tables on 10-K/Q SEC files without Goodwill.	SEC
Aggregate Purchase Price ($mil)	The fair value of aggregate purchase price in PPA tables on 10-K/Q SEC files.	SEC
Value of Transaction ($mil)	Value of Transaction.	SDC
Innovations($mln) $\$Innovations$	The sum of Developed Technology, Developed Rights, Patents and in-process R&D.	SEC

\$Innovations/ Value of Transactions	The sum of Developed Technology, Developed Rights, Patents, and In-process R&D divided by Value of Transaction.	SEC& SDC
Market data:		
Market Value$_{acquirer_{t-1}}$	The market value of an acquirer calculated as *abs(prc*shrout)* one month before deal announcement.	CRSP
Market Value$_{target_{t-1}}$	The market value of a target calculated as *abs(prc*shrout)* one month before deal announcement.	CRSP
Market Value$_{new\ entity_{t+1}}$	The market value of a joint entity calculated as *abs(prc*shrout)* one month after deal completion.	CRSP
Patent data	The data regarding patents were obtained from the KPSS database, https://github.com/KPSS2017/Technological-Innovation-Resource-Allocation-and-Growth-Extended-Data, and USPTO database.	
# of patents$_{acquirer(target)}$	The number of granted patents by an acquirer (target) firm during the 20-year window before the deal announcement.	KPSS
# of patents$_{new\ entity}$	The number of granted patents by a new entity firm during the 3-year window after deal completion.	KPSS
Dollar value of patent j $V^{t,T}(patent_j^f)$	The dollar value of patent j granted in year t by firm f and valued at the time of M&A deal T, as in equation (2).	KPSS& USPTO
Radical patent $q25(q10)$	Patent j is marked as radical when the number of received citations for this patent is more than 75% (90%) of all other patents at the same sector-year cohort. Formally, it holds if $I_j^{radical}$ equals 1, as in equitation (1).	USPTO
# of radical patents $_{target}$	The number of granted radical patents ($I_j^{radical} = 1$, as in equation (1))by a target firm during the 20-year window before the deal announcement.	KPSS& USPTO

# of radical patents $_{acquirer}$	The number of granted radical patents ($I_j^{radical} = 1$, as in equation (1))by an acquirer firm during the 20-year window before deal announcement.	KPSS& USPTO
Measurement of innovations for target companies:		
$\$Radical$	the dollar value of *radical* innovations produced by the target firm f at M&A date T, which is equal $\sum_{j=1}^{M_{T-20,T}} V^{t,T}(patent_j^f)$, where $M_{T-20,T}$ is the number of patents granted by firm f during the 20-year window prior to the M&A transaction, as in equation (3).	
$\$Incremental$	the dollar value of *incremental* innovation is derived as the difference between the total innovation value, *\$Innovations* and $\$Radical$, $\$Innovations_f - \$Radical_f$.	
Radical Fraction	the ratio between dollar value of *incremental* innovation and all purchased innovations $\$Incremental_f/\$Innovations_f$.	
Incremental Fraction	the ratio between dollar value of *radical* innovation and all purchased innovations $\$Radical_f/\$Innovations_f$.	
Measurement of performance for new entities companies:		
$Radical\ Innovations^{New\ Entity}$	The dollar value of *radical* innovations produced by the new firm f during the 3-year window after M&A date T scaled by total assets, as shown in equation (A3).	
$\Delta Sales^n_{t+i,t+j}$	A variables equals to growth in sales *(sale)* for two or three year period after deal announcement $(Sales_{t+j} - Sales_{t+i})/Sales_{t+i}$, where $j \in \{2,3\}$, years after the deal announcement, as shown in equation (A4).	Compustat
$Costs_{t+1}$	The dollar value of the cost of goods sold (cogs) scaled by sales (sale) next year after the deal announcement, as shown in equation (A6).	Compustat

$\Delta Sales^{a,t}_{t-1,t-2}$	The sales growth of the artificial firm is measured by the difference between the sum of the acquirer and target firm sales one year before the deal announcement and two or three years before the deal announcement, scaled by the sales from two or three years before the deal announcement, as shown in equation (A5).	Compustat
Accounting data:		
Cash/Total Assets	Cash *(ch)* divided by assets *(at)*.	Compustat
Debt/Total Assets	Debt *(dt)* divided by assets *(at)*.	Compustat
COGS/Total Assets	Cost of goods sold *(cogs)* divided by assets *(at)*.	Compustat
CAPEX/Total Assets	Capital Expenditures *(capex)* divided by assets *(at)*.	Compustat
Loss firm	A variable equals one if net income *(ni)* is more than zero, and minus one if net income *(ni)* is less than zero.	Compustat
Foreign Inc./Total Assets	Foreign Income *(pifo)* divided by assets *(at)*.	Compustat
R&D exp./Total Assets	Research and development expenses *(xrd)* divided by assets *(at)*.	Compustat
Diversifying	An indicator variable that equals one if the acquirer company and target company are assigned to the different 3-digit SIC industry, and zero otherwise.	Compustat
Age	The time between the year of measurement and the IPO date.	Compustat
Acquirer specific characteristics:		
Radical Inn./ Total Assets	The dollar value of radical patents granted to the acquirer firm during the 20-yer period before M&A date T, equation (3), scaled by total assets one year before the deal announcement.	Compustat &USPTO
$Patents/Total Assets	The dollar value of all patents granted to the acquirer firm during the 20-year period before M&A date T, scaled by total assets one year before the deal announcement.	Compustat &USPTO

Number of Acquisitions	The number of acquisitions performed by the company during the 10-year period before the deal announcement.	SDC
Deal specific characteristics:		
Cash deal	The binary variable that equals 1 if the deal was completed using only cash, and 0 otherwise.	SDC
Tender offer	The binary variable that equals 1 if the deal was completed through a tender offer, and 0 otherwise.	SDC
Number of bidders	The variable that counts the number of bidders participating in a particular M&A transaction.	SDC