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Review of Accounting Studies
https://doi.org/10.1007/s11142-021-09613-9

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Accepted: 9 June 2021/Published online: 09 November 2021

Abstract

The increasingly service-based U.S. economy relies on innovation. While there is considerable research on the importance of certain innovative activities, such as patents, less attention has been paid to unpatented innovation, about which there is naturally less publicly available information. Our study exploits disclosure on the fair value of acquired innovation to show that unpatented innovation plays an important, though often ignored, role in merger value creation. We detail the importance of unpatented technology and show that traditional approaches that rely only on R&D expenditures and patents lead to both misclassification of merger types and underestimates of the impact of innovation in value creation. Our evidence suggests that, on average, unpatented innovation accounts for a larger portion of synergies. We further show that higher (lower) gains accrue to the acquirer (the target) in relation to unpatented innovation, consistent with limited publicly available information about unpatented innovation reducing the target's bargaining power.

Keywords Intellectual property · Intangibles · R&D · Technology · Non-patented innovation · Trade secrets · Innovation · Purchase price allocations · Acquisitions · Mergers · Synergies

JEL classification G32 · G34 · M40

1 Introduction

Innovation increasingly drives growth in modern economies. However, the understanding of innovation primarily relates to patented innovation. Researchers know little

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about unpatented innovation, even though Rowe (2009) estimates its value at $5 trillion—roughly the same as the value of patented innovation in the Kogan et al. (2017) database. Indeed, research provides only limited evidence on the economic importance of unpatented innovation, for which there is little to no publicly available information. Our study provides a rare glimpse into unpatented innovation. We exploit the fair value of acquired innovation in mergers and acquisitions to measure unpatented innovation in over 1000 deals. We demonstrate that unpatented innovation plays an important, though often ignored, role in merger value creation.

Research has largely focused on observable innovation like patents. However, economists have long viewed patents as censored measures of innovation, recognizing that patent disclosures facilitate imitation and provide only limited legal protection (Bhattacharya and Ritter 1983; Horstmann et al. 1985; Cohen et al. 2000; Anton and Yao 2004; Hall et al. 2005, 2014).[1] In addition, as previously mentioned, exclusively focusing on patented innovation misses roughly half of the value of innovation in the United States. Further, we show that relying on only patents could lead to misclassification. Specifically, we discover that the combined firm determines the value of the target's pre-merger patented innovation as zero in many acquisitions.

Our study advances the literature on mergers and trade secrets. Although merger studies recognize that innovation, whether patented or not, creates synergies, researchers have lacked data to provide evidence on the relative contribution of unpatented innovation. For example, Phillips and Zhdanov (2013) develop a model predicting that firms can acquire innovation via mergers as a substitute strategy for conducting R&D themselves, but they are agnostic about whether the acquired innovation is patented. The empirical analysis of Bena and Li (2014) presents evidence that firms with more patents are less likely to become targets while firms with more R&D expenses and less growth in patenting are more likely to be acquired. Although their empirical findings suggest that unpatented innovation is a potential motivation for mergers, our study fills the gap by documenting the importance of unpatented innovation.

Second, by examining the value of unpatented innovation in a new setting, we add to recent research that examines the propensity of firms to patent, firms' reliance on trade secrets, and innovation-related disclosure choices (Glaeser 2018; Glaeser et al. 2020). Specifically, we use the required post-merger SEC filings to extract merger-specific fair values of the acquired assets for a sample of 1035 mergers involving publicly traded acquirers and targets from 2001 to 2015. We find that 332 deals recognize innovation-related intangible assets (technology and in-process R&D), whereas the 703 deals in the sample complement do not.

Even in the 703 deals that do not recognize innovation-related intangible assets, there is an important insight related to innovation. We find that 211 these deals involve targets with either unexpired pre-merger patents, pre-merger R&D expenditures, or both.[2] Thus relying

[1] Survey evidence over the past 30 years reveals that most business owners consider unpatented innovation (e.g., trade secrets) as a more important form of protection than patents (Levin et al. 1987; Cohen et al. 2000; Jankowski 2012).

[2] These 211 mergers represent the union of 175 mergers in which targets have unexpired patents and 144 mergers in which targets report R&D expenditures. We calculate unexpired patent market values using a twenty-year straight-line amortization schedule, where initial patent market values are based on the patent approval announcement date returns following Kogan et al. (2017). We calculate capitalized R&D, based on R&D expenditures reported in the target's pre-merger income statements using the industry amortization estimates from Lev and Sougiannis (1996).

on pre-merger patents or R&D expenditures could misclassify about 30% of these deals as innovation-driven. We conjecture that the reason for the target's innovation not to be valued by the combined firm is either because its R&D projects have not been successful or have become obsolete or because the target's patents are not closely related to the acquirer's primary business (Akcigit et al. 2016).

In the 332 deals that record an innovation asset, the aggregate fair value of innovation is 1.6 times greater than the aggregate capitalized R&D estimate. Similarly, 59 out of these 332 deals involve targets with no pre-merger patenting. Overall, these findings suggest that the expected future cash flows from innovation recognized in the merger differ considerably from the input values presented by pre-merger R&D expenditures and from pre-merger patenting.

We use three approaches to identify unpatented innovation. First, we conduct our tests using a subsample of mergers in which targets have no patents during the 20 years prior to the merger. Second, we build on the industry-based methodology of Glaeser et al. (2020) to approximately decompose the amount of the purchase price allocated to technology and in-process R&D into a patented component and a residual, unpatented component. Third, as a robustness test, we decompose the amount of the purchase price allocated to technology and in-process R&D into patented and unpatented components based on targets' pre-merger patent market values that we draw from the Kogan et al. (2017) database. Our tests then examine measures of merger wealth effects, such as synergy, acquirer returns, target premia, and the distribution of gains between acquirers and targets.[3]

We begin our analysis on a subsample of 579 mergers in which targets have no patents during the 20 years prior to the merger. Analyzing our results on this select sample is important as the mere absence of patenting allows us to cleanly identify acquired unpatented innovation. Approximately 10% of the deals (59 of 579) in this subsample involve the acquisition of technology and in-process R&D, which we fully attribute to the fair value of the target's unpatented innovation. We find that, on average, unpatented innovation represents 1.4% of the purchase price but accounts for 6.2% of merger synergies, a result that obtains after controlling for firm and deal characteristics as well as industry and time effects. We also observe that unpatented innovation is associated with higher wealth gains for acquirers and lower gains to targets. Relative to tangible assets and patented intangible assets, about which there is publicly available information, the target likely gives up some (proprietary) information related to its unpatented intangible assets, such as trade secrets. Hence revealing trade secrets weakens the bargaining power of the target and lowers their relative share of synergy gains in deals involving unpatented innovation. In addition, we find that this result especially pertains to unpatented technologies rather than unpatented in-process R&D projects. This is consistent with proprietary costs being more pronounced for

[3] In addition to traditional wealth effect estimates, we make two adjustments to account for merger transactions' endogenous nature. First, following Wang (2018), we use price reactions to exogenously withdrawn deals as a proxy for the change in the acquirer's stock price had the takeover not occurred. Second, we introduce a two-step process that adjusts the traditional three-day acquirer price reaction for the extent to which a merger announcement reveals new information about the acquirer's standalone value (e.g., overvaluation and limited organic growth opportunities) and for the probability that investors anticipate the merger. We document merger wealth effects that are generally consistent with those in prior research, suggesting that our sample of mergers involving public acquirers and targets is not unusual.

finished projects (unpatented technologies) that are directly implementable by the acquirer, as opposed to unfinished in-process R&D projects that would still require a considerable time and financial investment on part of the acquirer.[4]

To analyze whether the results in our full sample of 1035 mergers are consistent with the results on the subsample of targets without prior patenting, we turn to a decomposition of patented and unpatented innovation. Using the industry methodology, we estimate that the acquirers in our sample pay in aggregate $30 billion for patented innovation and $83 billion for unpatented innovation. Consistent with the previous subsample analysis, we find that unpatented innovation represents more than 12% of synergy gains, while less than 3% of merger synergy value is associated with the acquisition of patented innovation. Whereas prior research shows that patented innovation enhances the value of mergers (Sevilir and Tian 2012) or that patent complementarity enhances future research output (Bena and Li 2014), we find that the previously unexamined unpatented innovation is also associated with considerable value creation, suggesting that studies have underestimated the synergistic value of innovation.[5]

Finally, we use mergers withdrawn for reasons unrelated to innovation activities as a quasi-experiment to estimate the treatment effect of acquiring innovation on post-merger profitability (e.g., Savor and Lu 2009; Seru 2014; Bena and Li 2014). We find that mergers acquiring innovation do not have differential profitability from exogenously withdrawn mergers but mergers that do not acquire any innovation-related assets experience lower profitability after merger consummation. This ex-post treatment effect is consistent with the ex-ante wealth effect around initial merger announcements.

Our study advances several streams of research. First, whereas theoretical justifications for synergy gains are abundant, without access to detailed merger-specific data, researchers have found it difficult to identify the sources of these gains (Jensen and Ruback 1983; Healy et al. 1992; Kaplan 2000; Andrade et al. 2001; Betton et al. 2008). Our evidence suggests that merger-specific fair values of acquired assets enable researchers to study unpatented innovation as a source of synergy and that these fair values can be informative about the division of synergy gains between acquirers and targets.

Second, our study also relates to the recently emerging trade secrets literature in accounting. For example, Glaeser (2018) examines the relation between trade secrets and company voluntary disclosure choice and finds that firms that rely more on trade secrecy disclose less proprietary information. Similarly, recognizing that patenting also

[4] While our above argument relates to the weaker bargaining power at the target, our findings are also consistent with the possibility that the acquirer's larger wealth gains arise from acquirers being more knowledgeable about the target's innovations, either because of their own related research experiences or because of a pre-bid strategic alliance. Higgins and Rodriguez (2006) provide evidence consistent with this conjecture in a setting of pharmaceutical mergers. In addition, Bushee et al. (2020) show that firms in highly competitive technology industries share information via their participation in standard setting organizations.

[5] Our findings are robust to (i) an alternate decomposition approach using target firms' pre-merger patent market values that we draw from the Kogan et al. (2017) database; (ii) alternate merger wealth measures that adjust for industry shocks, partial anticipation, and signals about the acquirer's standalone valuation; (iii) alternate merger wealth measures that rely on the estimated synergy losses in exogenously withdrawn deals; (iv) using only 3 years prior to the merger to identify targets' patents; and (v) extending the announcement window to up to 10 days before the announcement.

constitutes a form of disclosure, Glaeser et al. (2020) investigate whether manager decision horizons influence the firm's patent propensity. Collectively, these studies illustrate the importance of unpatented trade secrets. We contribute to this literature by quantifying the importance of unpatented innovation for the creation of merger synergies and the wealth effects to acquirers and targets.

Third, and more broadly, our study speaks to the macroeconomic literature on innovation. Economists often rely on input values, such as R&D expenditures, to assess the role of innovation in the creation of economic growth (e.g., Corrado and Hulten 2010; McGrattan and Prescott 2014; Koh et al. 2020; Bloom et al. 2020). However, our results suggest that relying on patents and R&D expenditures understates the importance of innovation. Our evidence on merger wealth effects suggests that the unmeasured innovation component is economically important.

The remainder of the paper proceeds as follows. Section 2 reviews studies and discusses our empirical framework. Section 3 describes our methodology. Section 4 provides the results of our empirical tests, and Section 5 concludes.

2 Prior research and empirical framework

2.1 Innovation, patents, and trade secrets

Understanding the relation between innovation and economic growth has been a fundamental question in the economics, finance, and accounting literatures. Researchers have long recognized that not all R&D projects succeed and have relied on patent data to measure innovation output and the success of R&D.[6] Recently, Kogan et al. (2017) introduced a new measure of patent value based on the short-window equity market reaction to patent approvals. The authors argue that their measure captures the *ex-ante* market value assessed by investors, which differs from *ex-post* citations that focus on the scientific value of patents. Studies present abundant evidence that patent counts and citations, R&D expenditures, or the ratio of the two are positively associated with various measures of firm performance.[7] However, despite their importance, patents capture only part of the overall innovation in the economy.

Companies use various means to protect their proprietary innovations. Patents allow innovators to appropriate profits by temporarily excluding other parties from imitating the innovation. In exchange, the innovator must explain the innovation in a public disclosure, which allows other parties to avoid duplicating the research and to quickly imitate the innovation once the patent expires (Hall et al. 2014). In contrast, unpatented innovation, such as trade secrets, is not publicly disclosed and therefore difficult to observe empirically. Generally, the trade secret law in the United States provides weaker protection than the

[6] For example, Scherer (1965) and Griliches (1981) show a positive relation between patent counts and R&D expenditures. Researchers also use patent citations to better capture the heterogeneity in the quality of patents. For example, Trajtenberg (1990) validates patent citations as a measure of patent quality by documenting its positive relation with social surplus, while Lanjouw and Schankerman (2004) document a positive relation between citations and the likelihood of patent renewals.

[7] Examined performance measures include Tobin's Q, accounting profitability, stock returns, and economy-wide aggregate productivity (Griliches 1981; Deng et al. 1999; Eberhart et al. 2004; Hall et al. 2005; Gu 2005; Hsu 2009; Pandit et al. 2011; Hirshleifer et al. 2013; Farre-Mensa et al. 2016; Kogan et al. 2017; Curtis et al. 2020).

patent law (Kewanee Oil Co. v. Bicron Corp., 416 U.S. 470, 1974). Yet most firms view trade secrets (unpatented innovation) as a more important form of protecting the economic rents associated with innovation than patents. For example, 42% of R&D firms consider utility patents as an important safeguard, while 67% of R&D firms consider unpatented innovation as an important means of protection. (See a summary of the National Science Foundation's Business R&D and Innovation Survey in Jankowski 2012.) Furthermore, the importance of unpatented innovation has increased significantly since the 1980s and 1990s. (See the 1981–1983 survey of Levin et al. 1987 and a 1994 survey by Cohen et al. 2000.)

An important question is why do firms choose not to file for a patent? Survey respondents often cite the fact that their competitors could use the publicly disclosed information in patent applications to legally invent around the patent as an important reason to not file (Levin et al. 1987; Cohen et al. 2000). This concern is more acute after the passage of the 2000 American Inventor's Protection Act, which requires innovators to publicly disclose patent applications upon filing, regardless of whether the application would eventually be granted. Several theoretical studies have formalized the trade-offs between the loss in competitive advantage that results from the public disclosure of private knowledge about innovation and the benefits of the protection conferred by patents (Bhattacharya and Ritter 1983; Horstmann et al. 1985; Anton and Yao 2004). Analytical results often suggest that, because of proprietary cost concerns, firms may choose to not patent their most valuable innovations.

By construction, unpatented innovations or trade secrets are rarely observable, which creates challenges in empirically documenting their economic impact. Studies have relied on surveys and companies' own disclosures to identify the existence of trade secrets or use changes in the legal framework that governs secrecy to infer their use (Levin et al. 1987; Cohen et al. 2000; Carr and Gorman 2001; Lerner 2006; Png 2017; Glaeser 2018). Our study exploits the purchase price allocation disclosure that details acquired intangible assets to uncover the economic impact of unpatented innovation and trade secrets.

2.2 Purchase price allocation disclosure

Since the passage of Statement of Financial Accounting Standards No. 141 and No. 142 in 2001, merging firms have been required to disclose detailed fair values of acquired intangible assets (e.g., in-process R&D, technology, trademarks, client relationships, or legal rights; see Fig. 1 for details and Appendix 1 for an example).[8] Prior to the passage of this accounting standard, only net tangible assets, goodwill, and intangible assets that were already recognized in the target's balance sheet prior to the merger had to be separately disclosed by the merged firm.[9] Given the growing importance of innovation in the service-

[8] SFAS No.141 was revised in 2007 but retained the year 2001 guidance for identifying and recognizing intangible assets separately from goodwill (https://www.fasb.org/pdf/fas141r.pdf). In 2009, the Financial Accounting Standards Board (FASB) transformed SFAS 141 and 142 to Accounting Standards Codification (ASC) 805 and 350.

[9] SFAS No. 2 issued by FASB in 1974 required firms to immediately expense costs (i.e., materials, salaries, equipment, and facilities) pertaining to research and development (https://www.fasb.org/resources/ccurl/286/565/fas2.pdf). The basis for this accounting treatment is the high uncertainty about whether a R&D project will generate future revenue. Only intangible assets acquired from an external entity can be recognized in a firm's balance sheet (see SFAS No. 86 at https://www.fasb.org/pdf/fas86.pdf).

based U.S. economy, financial statement users indicated a need for better information about the nature of acquired intangible assets in mergers.[10] The disclosed fair values are determined by independent appraisers based on the "highest and best use" value in the most advantageous market and are audited by the firm's independent auditors.

Research on the acquisition of innovation has primarily focused on patents. As discussed earlier, the lack of empirical evidence on the importance of unpatented innovation is likely driven by firms' reluctance to share their proprietary information via public registrations. Purchase price allocation (PPA) disclosures are the outcome of the acquirer's due diligence and make visible previously unpatented forms of innovation and thus potentially provide new information about the nature of acquired innovation, which can help investors and researchers understand the sources of merger value creation.

Accounting studies using PPA data often focus on the allocation to goodwill and overlook the sources of innovation that we examine. For instance, Shalev (2009) conjectures that acquirers obfuscate by allocating greater amounts to goodwill and documents a negative relation between the portion of the purchase price allocated to goodwill and the level of detail in the PPA disclosure.[11] Studies by Kimbrough (2007) and Potepa and Welch (2018) are exceptions in the sense that both examine innovation-related intangible assets from the PPA disclosure. Kimbrough shows that the target's *pre-merger* equity value is positively associated with the allocation to innovation, including in-process R&D and technology, as evidence to support the idea that investors partially possess information about R&D not recognized in the target's pre-merger financial statements. He further examines analyst coverage as a channel by which investors can access information about targets' pre-merger innovations, consistent with evidence that investors attach future value to the R&D of loss firms (Joos and Plesko 2005). Potepa and Welch (2018) document a positive relation between the amount of the purchase price allocated to intellectual property (i.e., in-process R&D, technology, and trademarks) and two commonly used innovation proxies (pre-merger trademark counts and patent approval announcement returns) but fail to show a significant association with the other innovation proxies (pre-merger patent counts, patent citations, and R&D expenditures). Overall, while there has been prior work on purchase price allocations, we offer new evidence on the relation between the allocation to innovation and the shareholder wealth effects.[12]

[10] See the reasons for issuing SFAS 141 and SFAS 142 at https://www.fasb.org/summary/stsum141.shtml and https://www.fasb.org/summary/stsum142.shtml.

[11] Shalev et al. (2013) further argue that CEOs with a higher bonus to total compensation ratio have incentives to over-allocate the purchase price to goodwill, because goodwill is not subject to amortization, leading to temporarily overstated earnings before goodwill impairments. Zhang and Zhang (2017) use the acquirers' market-to-book ratio, the portion of nonfinancial assets, and the age of the CEO as additional proxies for acquirers' incentives to overstate the allocation to goodwill. In contrast, Lynch et al. (2019) argue that firms may understate the amount allocated to goodwill for future tax saving purposes. Paugam et al. (2015) also focus on the portion of the purchase price allocated to goodwill and examine its relationship with market reactions around the SEC filings of PPA disclosures.

[12] Recent studies that use PPA disclosures do not exploit the detailed components of intangible assets. Aleszczyk et al. (2019) present a positive relation between the fair value adjustment for tangible assets and post-merger debt financing. McInnis and Monsen (2019) document a positive association between post-merger operating income and the fair value of acquired assets. King et al. (2019) and Bauman and Shaw (2018) present a positive relation between post-merger stock price and the fair value of acquired assets.

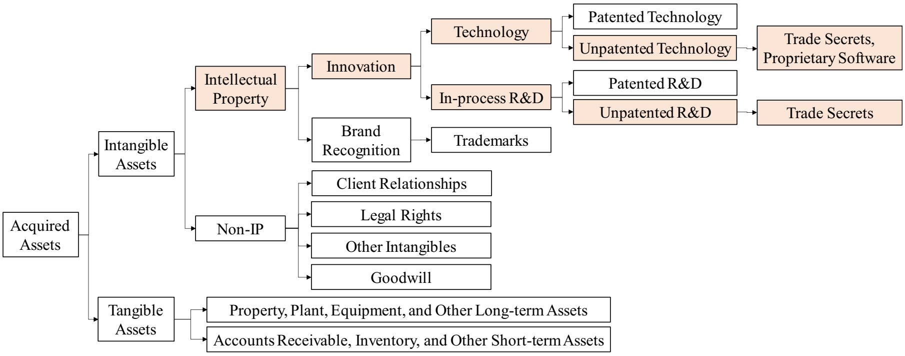

Fig. 1 Decomposition of Acquired Assets in Mergers. This diagram decomposes the target's assets into tangible and intangible assets, depending on their physical form. The intangible assets are decomposed into intellectual property (IP) and non-IP, based on the WIPO's definition. Technology (in-process R&D) represents (in)complete projects that have (not) reached technological feasibility upon completion of the acquisition. Technological feasibility implies that all necessary planning, designing, coding, and testing have been completed to establish commercial products (e.g., proprietary software). In Section 3.2, we discuss our estimation approach, which decomposes technology or in-process R&D into a patented component and an unpatented component. A trademark is a word, symbol, or phrase, used to identify a manufacturer's or seller's products and distinguish them from the products of another manufacturer (the Lanham Act 15 U.S.C. § 1127). Client relationships are contractual agreements with a target's customers, including order backlogs, contracts (e.g., mobile phone subscriptions), and anticipated future contracts. Client relationships also include customer lists and their associated formal and informal commitments. Legal rights and noncustomer contracts provide competitive advantages by bargained prices (e.g., licensing, franchising, and lease agreements) or exclusive access to rare resources (e.g., drilling, water, air, etc.). Other intangibles include all separately identified intangible assets that do not belong to the above categories. Goodwill is the residual amount of the purchase price that cannot be attributed to any identifiable intangible asset. Tangible assets include short-term and long-term assets, according to U.S. GAAP

2.3 Mergers and acquisitions

There is extensive evidence of aggregate value creation in mergers. While theoretical justifications for synergy gains are abundant, without access to detailed merger-specific data researchers have found it difficult to identify the sources of such gains, even in smaller samples and clinical studies (Jensen and Ruback 1983; Healy et al. 1992; Kaplan 2000; Andrade et al. 2001; Betton et al. 2008).[13] Some studies focus on smaller samples with detailed economic information about individual acquisitions. For example, Beneish et al. (2008) draw on data that became publicly available as a result of the tobacco litigation settlement to study acquisitions by a small group of homogenous firms in the tobacco industry. They show that geographic diversification enables tobacco firms to gain political influence and reduce expected expropriation costs.[14] However, while these studies are informative about the sources of synergy in specific

[13] Synergistic gains have been suggested to arise from (1) exploiting economies of scale, (2) obtaining operating synergies from vertical integration, (3) obtaining tax benefits, (4) replacing inefficient management, (5) increasing debt capacity, and (6) creating an improved internal capital market (e.g., Teece 1980; Ravenscraft and Scherer 1987; Healy et al. 1992; Shleifer and Vishny 1992).

[14] As another example, Devos et al. (2009) study a sample of 264 mergers involving firms followed by Value Line from 1980 to 2004. They exploit the rich set of forecasts provided by Value Line (e.g., earnings, revenues, cash flows, and investments) for acquirers, targets, and the combined firm and show that value creation stems from operating synergies in related mergers and from tax savings in diversifying mergers.

settings, it is unclear whether these findings translate to the broader universe of mergers.

Several studies have examined a particular source of synergy in larger samples. Hoberg and Phillips (2010) focus on product market synergies, described as the ability of merging firms to create new and unique products that complement an acquirer's existing products and that enable the merged firm to better differentiate itself from rivals. They find that firms with a more similar product market language are more likely to merge, experience higher announcement returns, and generate higher profitability and greater growth in sales and product offerings in the long run. Some studies have investigated the importance of innovation as a source of synergy. Sevilir and Tian (2012) suggest that merger wealth effects are greater when the target has filed for at least one patent during the three years prior to the merger and conclude that acquiring innovation creates value. Using both textual analysis and patent data, Bena and Li (2014) find greater post-merger patent output, suggesting that synergies arise when acquisitions involve complementary innovations.[15] Our study differs because our merger-specific data allows us to examine several sources of synergy simultaneously and because we can identify both patented and unpatented innovation.

Finally, our study relates to research that examines post-merger long-run performance and changes in firm behavior. Using manufacturers' plant-level data, Maksimovic and Phillips (2001) and Schoar (2002) document improvements in total factor productivity during the two years following a merger. Specifically, acquirers reduce target's wage rates, material inputs, and investments, but the corresponding outputs do not decline proportionally (Li 2013). Moreover, following the merger, acquirers sell productivity-declining plants and retain productivity-enhancing ones (Maksimovic et al. 2011). More recent studies focus on different aspects of synergistic gains for nonmanufacturing firms. In the consumer goods industry, Sheen (2014) documents an increase in product quality and a decrease in selling prices for up to five years after mergers. On the other hand, Seru (2014) focuses on innovative industries and finds that successfully merged firms produce more and higher quality patents than a control group of firms that failed to be acquired for reasons unrelated to their innovations. In contrast, we mainly focus on studying value creation at merger announcements, to avoid concerns that post-merger improvements can be related to unobservable common shocks (Andrade et al. 2001) or changes in the business strategy unrelated to anticipated merger synergies (Phillips and Zhdanov 2013). However, in our supplemental analyses using exogenously withdrawn deals as a control group, we show that mergers that involve the acquisition of innovation have better long-run performance than those in which no innovation is acquired.

[15] Relatedly, in a 2010 survey of 5000 U.S. manufacturers, 49% of the firms responded that their innovations come from external sources and 10% of externally sourced innovations are obtained through mergers and acquisitions (Arora et al. 2016). Alimov and Officer (2017) document higher synergy gains when an international target is from an emerging country that has strong patent protection laws. Using textual analysis and trademark data, Hsu et al. (2018) show greater combined firm announcement returns when targets and acquirers share a similar class of trademarks prior to the merger. Further, Hsu et al. (2020) present that new trademarks are positively associated with future firm profitability and stock returns.

2.4 Merger wealth effects

We follow prior studies (e.g., Moeller et al. 2004; Cai and Sevilir 2012) and rely on merger announcement returns to infer investors' expected merger synergies. Using Phillips and Zhdanov's (2013) notation, the price paid to the target shareholders is as follows.

$$P = V_t^s + \eta\left(V_m - V_t^s - V_b^s\right), \tag{1}$$

where V_m is the value of the combined firm. V_t^s and V_b^s are the standalone values of the target and the bidder. Merger synergy is captured by the combined firm's value minus the sum of the standalone values, that is, $\left(V_m - V_t^s - V_b^s\right)$, and η presents the target's relative bargaining power or the fraction of the merger synergies paid to target shareholders. The fair values of acquired assets enable us to examine the relation between innovation-related assets and merger synergies as well as the distribution of gains across acquirers and targets.

From the earlier discussion, we expect that unpatented innovations affect the distribution of synergy gains between acquirers and targets as a function of their relative bargaining power. Whereas there is voluminous public information about tangible assets or patented innovations (via either financial reports or patent application filings), there is little about unpatented innovations. Hence, during the M&A process, targets may be required to reveal at least some details about their unpatented innovations to the acquirer. Yet this puts targets in a vulnerable position, as they share information on innovations that are not formally protected. Hence, even if acquirers were to walk away from a deal, they could exploit the information shared by the target in the negotiation. Overall, this lowers targets' expected monopolistic profits from trade secrets and results in a weakened bargaining position.[16] Higgins and Rodriguez (2006) present an alternative argument for why acquirers can have greater bargaining power and achieve higher gains from acquiring innovation. They argue that higher gains accrue to acquirers that are better informed about the innovations of the target, either because of their experience in the same area of research or because of a prior partnership on a specific R&D project.

3 Method

3.1 Empirical model

We examine the relation between the fair values of acquired intangible assets and merger wealth effects using the following model specification.

[16] One may question why targets would be willing to share information with the acquirer, instead of using these innovations themselves. However, as argued by Phillips and Zhdanov (2013), an active M&A market creates incentives for (smaller) firms to invest in R&D in the expectation of being acquired by (larger) firms that need these innovations. Hence some firms will innovate with the intention of being acquired, instead of bringing products to the market themselves.

$$
\begin{aligned}
\Delta \text{WEALTH}_j = {} & \beta_1 \text{TECH}_j + \beta_2 \text{IPR\&D}_j + \beta_3 \text{TRADEMARK}_j + \beta_4 \text{CLIENTS}_j \\
& + \beta_5 \text{RIGHTS}_j + \beta_6 \text{GOODWILL}_j + \beta_7 \text{INT\_OTHER}_j \\
& + \eta_1 \text{RELATIVESIZE}_j + \eta_2 \text{TENDER}_j + \eta_3 \text{DIVERSIFY}_j \\
& + \eta_4 \text{SIZE}_j^A + \eta_5 \text{BTM}_j^A + \eta_6 \text{TAX}_j^A + \eta_7 \text{RUNUP}_j^T \\
& + \eta_8 \text{CAPRD}_j^A + \eta_9 \text{CAPADV}_j^A + \eta_{10} \text{INTAN}_j^A + \Sigma y_t + \text{Year}_t + \Sigma d_n \text{Industry}_n + \varepsilon_j,
\end{aligned} \tag{2}
$$

where ΔWEALTH_j captures different merger wealth effects for deal j related to four different measures: (1) synergies (SYN), measured as the combined firms' announcement return; (2) the acquirer's announcement return (ACAR); (3) the premium paid to target shareholders (PREMIUM); and (4) estimated gains to the target's shareholders relative to the acquirer's shareholders (TGAIN). Specifically, SYN is the three-day (−1, +1) cumulative abnormal return of a value-weighted portfolio of the acquirer and the target around the initial deal announcement. Weights are based on the acquirer's and target's market capitalizations two months prior to deal announcement and the percentage of the target's shares owned by the acquirer prior to the merger (i.e., toehold) is deducted from the target's weight. We use the CAPM to calculate expected returns, and we estimate the benchmark model parameters using daily returns over the the year that ends two months prior to the deal announcement. ACAR (TCAR) is the acquirer's (target's) three-day cumulative abnormal return around the initial deal announcement. PREMIUM is the initial offer price or the final offer price if the initial offer price is missing, divided by the target's stock price two months prior to the deal announcement, minus one (i.e., [(offer price / pre-merger price) -1]. PREMIUM is missing in 35 deals for which SDC does not report the offer price. We further set PREMIUM to missing for 16 deals where the premium is greater than 200%. Following the methodology of Ahern (2012), TGAIN is the dollar gain of the target (i.e., target's market capitalization × TCAR) minus the dollar gain of the acquirer (acquirer's market capitalization × ACAR), divided by the sum of the acquirer's and target's market capitalization.[17]

The purchase price allocation disclosure decomposes the merger purchase price into the fair values of net tangible assets and various components of the target's intangible assets (see Fig. 1). We use the percentage of the purchase price allocated to net tangible assets as a reference category and create seven intangible asset categories as the fraction of the purchase price allocated to technology (TECH), in-process R&D (IPR&D), trademarks (TRADEMARK), client relationships (CLIENTS), legal or contractual rights (RIGHTS), goodwill (GOODWILL), or other separately identifiable intangible assets (INT_OTHER). Please refer to Appendix 1 for an example of how we calculate these test variables.

Following prior studies (Moeller et al. 2004; Cai and Sevilir 2012; Lynch et al. 2019), we include three deal characteristics (RELATIVESIZE, TENDER, and DIVERSIFY) and seven firm-specific pre-merger characteristics (SIZE^A, BTM^A, TAX^A, RUNUP^T, CAPRD^A, CAPADV^A, INTAN^A) as control variables. INTAN^A is the book value of intangibles that are reported on the acquirer's balance sheet prior to the merger. CAPRD^A and CAPADV^A are the estimated pre-merger values of the acquirer's unrecorded R&D assets and trademarks, following the capitalization procedures of Lev and Sougiannis (1996) and Penman and Zhang (2002) and based

[17] In line with the other variables, market capitalizations are measured two months prior to deal announcement.

on the assumption that investors value unreported intangible assets derived from R&D and advertising (Joos and Plesko 2005; Kimbrough 2007).[18] We include the acquirer's pre-merger recognized and unrecognized intangible assets to capture potential complementarities (Rhodes-Kropf and Robinson 2008).[19] We do not include the target's pre-merger recognized and unrecognized intangible assets to avoid double counting when including the fair values of acquired intangible assets from the purchase price allocation disclosure. We include year fixed effects ($\sum y_t \text{Year}_t$) and industry fixed effects based on the acquirer's Fama-French 12 industry classification ($\sum d_n \text{Industry}_n$), and we cluster standard errors at the acquirer level to capture unobservable time, industry, and serial acquirer factors. We winsorize all variables at the first and 99th percentiles to avoid potential data input errors.

3.2 Decomposing patented and unpatented innovation

We use an industry-based method, following Glaeser et al. (2020), to decompose the amount of the purchase price allocated to technology and in-process R&D (IPR&D) into a patented component and a residual, unpatented component. While decomposing acquired technology is plausible, as technology likely has both patented and unpatented components, the motivation for decomposing acquired in-process R&D merits further discussion.

In-process R&D represents incomplete projects that have not yet reached technological feasibility, but as new knowledge is generated, firms file for patents before R&D projects become commercially viable. As such, consistent with accounting guidance, the in-process R&D recognized in a merger or acquisition can include both unpatented and patented components so long as they are part of an ongoing R&D project.[20] Because firms do not typically disclose the components of acquired in-process R&D, we cannot provide systematic evidence that patents are included in it. However, SEC correspondence presents occasional insights on what is included and suggests that patents can be part of in-process R&D.[21]

[18] The financial economics literature has moved to incorporate intangibles into popular valuation metrics. See Peters and Taylor (2015), Park (2020), Eisfeldt et al. (2020), Li (2020) and Arnott et al. (2021).

[19] In untabulated analyses, as a robustness check, we include additional deal and firm characteristics (e.g., an indicator for stock only deals, hostile deals, mergers of equals, or mergers with competing bids; the target's pre-merger book-to-market ratio; the acquirer's stock price run-up; both merging firms' profitability, age, and analyst coverage). None of these additional control variables are significantly associated with merger synergy.

[20] The AICPA guide on Assets Acquired to Be Used in Research and Development Activities Section 2.37, which states: "… to the extent that individually completed intangible assets are solely and directly related to [in-process R&D] projects that are still in development (for example, in the pharmaceutical industry, a patent on a compound that has not yet been approved), such assets may be aggregated with other intangible assets used in R&D activities. That is, an acquirer would recognize one asset for each [in-process R&D] project, which would comprise all the intangible assets used exclusively in that project, and that asset would be assigned an indefinite useful life." In effect, any patents filed as part of an ongoing R&D project are treated as part of the in-process R&D intangible rather than a separate technology intangible.

[21] For example, in its reply to an inquiry of the SEC concerning its measurement of in-process R&D, Spectrum reports on September 21, 2013, that its valuation of in-process R&D in the Allos acquisition includes the patents supporting the FOLOTYN technology because there "are a number of substantive steps before this technology is complete and ready for full commercialization …" Similarly, AmpliPhi Biosciences, states: "As such, we considered section 2.37 of the IPR&D guide to apply and as such the acquired patents and phage and bacterial banks were recognized as part of the IPR&D project…[as they] were at a stage where they could be utilized to test and develop new therapies" in responding to an inquiry of the SEC on May 22, 2014 concerning their measurement of IPR&D.

Based on these observations, we decompose acquired technology and in-process R&D into patented and unpatented components. We modify the industry-based methodology of Glaeser et al. (2020) in the following ways to address our distinct research question. First, Glaeser et al. (2020) regress the estimated value of R&D stock on the market value of patents and estimate R&D stock based on the capitalization schedule of Chan et al. (2001). We replace the R&D stock estimate with the fair value of technology or in-process R&D disclosed in mergers and acquisitions. Thus we relate to the estimated value of patents, the fair value of acquired innovation intangibles, rather than an estimate of past R&D investment. Second, we estimate the pooled regression below for each Fama-French 12 industry to which a target firm belongs. We choose the 12-industry classification rather than the 48-industry classification, as do Glaeser et al. (2020), because only 332 deals recognize technology or in-process R&D in our sample.[22]

We use the following equation for each target Fama-French 12 industry.

$$\mathrm{TECH\$_j / IPR\&D\$_j} = \delta_1 \mathrm{PATENTSTOCK\$_j^T} + \varepsilon_j, \qquad (3)$$

where $\mathrm{TECH\$_j}$ ($\mathrm{IPR\&D\$_j}$) is the dollar value in millions used to acquire technology (in-process R&D) in deal j and $\mathrm{PATENTSTOCK\$_j^T}$ is the estimated market value in millions of the target's pre-merger patents. Patent market values are obtained from Kogan et al. (2017) and are based on the equity market reaction to patent approvals. Based on the legal protection period of patents, we use the 20 years prior to the merger to capture the target's pre-merger patent base. Our results are robust to using the three years prior to the merger instead (in line with Sevilir and Tian 2012). Because the Kogan et al. database ends in 2010, for the period after 2010, we collect the pre-merger patent data from the Google Patent website and use the three-day (−1, +1) cumulative abnormal return around the patent publication date as the estimated market value. We then calculate the patent stock for the target of deal j announced in year t as follows (with $N = 20$).

$$PATENTSTOCK\$_t = \sum_{k=1}^{N} \left(1 - \frac{k-1}{N}\right) \times PATENT\$_{t-k}. \qquad (4)$$

We refer to the fitted value in Eq. (3) as patented technology/in-process R&D and the residuals as unpatented technology/in-process R&D. For two industries with insufficient observations, we estimate Eq. (3) based on observations from all industries. We define TECH_PATENT (IPRD_PATENT) as the fitted dollar value of patented technology (patented in-process R&D) divided by the deal value and TECH_UNPATENT (IPRD_UNPATENT) as the difference between TECH (IPRD) and TECH_PATENT (IPRD_PATENT).[23] We caution that the decomposition is only an approximation and thus subject to measurement error.

[22] We also set the intercept to zero, which assumes that, if the target does not have any pre-merger patents, recognized technology or in-process R&D intangibles are zero. Although this is not the case in the 59 deals in which the acquirer recognizes technology or in-process R&D, despite the absence of target patents, the assumption of zero intercept preserves the estimation of the unpatented components because the fitted value is zero for these cases.

[23] TECH_PATENT (IPRD_PATENT) is set to equal TECH (IPRD) if TECH (IPRD) is less than or equal to the fitted value. In that case, all the TECH (IPRD) is patented, and the unpatented components are correspondingly zero.

4 Data and results

4.1 Sample selection

Our sample is based on completed mergers announced between 2001 and 2015, involving listed acquirers and targets, at the intersection of SDC, CRSP, and Compustat. As described in Table 1, from the 2755 SDC completed deals involving public acquirers and targets for which we have data in both CRSP and Compustat, we drop 138 deals with transaction values less than $5 million, 395 deals in which the transaction value is less than 1% of the acquirer's market capitalization, 83 deals in which the acquirer previously owned a controlling interest (i.e., 50% or more) in the target, and 393 deals with missing Compustat data on some of the variables included in our analyses. Out of the remaining 1746 deals, we identify 1251 deals (approximately 72%) for which the purchase price allocation disclosure is available from SEC EDGAR filings. The 495 deals without PPA disclosure information relate to foreign incorporated firms, investment management vehicles, or both. We further exclude 216 deals in which net tangible assets (i.e., tangible assets minus liabilities) are negative because we use the portion of the merger purchase price allocated to net tangible assets as a reference category.

4.2 Descriptive statistics

Table 2, Panel A, reports descriptive statistics for the variables based on the sample of 1035 mergers. The mean (median) acquirer wealth effect, measured as the acquirer's three-day cumulative abnormal return around the deal announcement (ACAR), is −1.2% (−0.8%). This comports with prior research, in terms of both direction and magnitude. For example, Moeller et al. (2004) and Ahern (2012) report negative acquirer returns for public acquisitions of −1.0% and − 1.3%, respectively. A lower

Table 1 Sample Selection

	No. of deals
2001–2015 SDC completed deals involving public bidders and public targets based on CRSP	2,755
Less:	
Deals with a value less than $5 million	138
Deals with a value less than 1% of the acquirer's market capitalization	395
The acquirer already owned more than 50% of the target firm prior to the merger	83
Deals with insufficient data in Compustat	393
SDC/CRSP/Compustat sample before requiring purchase price allocation data	1,746
Less:	
Deals that do not have purchase price allocation data	495
Deals whose purchase price allocation indicates negative net tangible assets	216
Final Sample	**1,035**

This table describes the construction of our final sample of 1035 completed deals announced between 2001 and 2015

Table 2 Variable Distribution

Variable	N	Mean	Median	Std Dev	Variable	N	Mean	Median	Std Dev
Panel A Full Sample									
SYN	1,035	0.025	0.015	0.064	TRADEMARK	1,035	0.017	0.000	0.060
ADJ_SYN	1,035	0.036	0.026	0.065	CLIENTS	1,035	0.035	0.000	0.076
WDADJ_SYN	942	0.069	0.067	0.072	RIGHTS	1,035	0.007	0.000	0.040
ACAR	1,035	−0.012	−0.008	0.067	GOODWILL	1,035	0.429	0.454	0.235
ADJ_ACAR	1,035	0.002	0.002	0.071	INT_OTHER	1,035	0.073	0.011	0.122
WDADJ_ACAR	942	0.042	0.050	0.079	RELATIVESIZE	1,035	0.478	0.255	0.684
TCAR	1,035	0.255	0.208	0.228	TENDER	1,035	0.148	0.000	0.355
PREMIUM	984	0.380	0.325	0.327	DIVERSITY	1,035	0.286	0.000	0.452
TGAIN	1,035	0.043	0.034	0.064	$SIZE^A$	1,035	14.590	14.482	1.833
TECH	1,035	0.032	0.000	0.077	BTM^A	1,035	0.528	0.480	0.313
TECH_PATENT	1,035	0.002	0.000	0.015	TAX^A	1,035	0.635	0.000	2.494
TECH_UNPATENT	1,035	0.030	0.000	0.076	$RUNUP^T$	1,035	0.056	0.030	0.215
IPR&D	1,035	0.022	0.000	0.088	$CAPRD^A$	1,035	0.064	0.000	0.104
IPRD_PATENT	1,035	0.002	0.000	0.016	$CAPADV^A$	1,035	0.004	0.000	0.011
IPRD_UNPATENT	1,035	0.021	0.000	0.092	$INTAN^A$	1,035	0.165	0.069	0.195
Panel B No Patent Subsample									
SYN	579	0.027	0.016	0.061	TRADEMARK	579	0.012	0.000	0.054
ADJ_SYN	579	0.036	0.026	0.063	CLIENTS	579	0.020	0.000	0.059
WDADJ_SYN	523	0.076	0.071	0.067	RIGHTS	579	0.005	0.000	0.034
ACAR	579	−0.009	−0.008	0.063	GOODWILL	579	0.419	0.446	0.245
ADJ_ACAR	579	0.002	0.002	0.067	INT_OTHER	579	0.065	0.028	0.108
WDADJ_ACAR	523	0.050	0.055	0.073	RELATIVESIZE	579	0.524	0.276	0.729
TCAR	579	0.239	0.200	0.216	TENDER	579	0.078	0.000	0.268
PREMIUM	552	0.360	0.306	0.329	DIVERSITY	579	0.214	0.000	0.411
TGAIN	579	0.041	0.030	0.061	$SIZE^A$	579	14.245	14.201	1.644
TECH	579	0.008	0.000	0.041	BTM^A	579	0.598	0.556	0.311
TECH_PATENT	579	0.000	0.000	0.000	TAX^A	579	0.345	0.000	1.829
TECH_UNPATENT	579	0.008	0.000	0.041	$RUNUP^T$	579	0.052	0.028	0.209
IPR&D	579	0.007	0.000	0.057	$CAPRD^A$	579	0.017	0.000	0.058
IPRD_PATENT	579	0.000	0.000	0.000	$CAPADV^A$	579	0.003	0.000	0.010
IPRD_UNPATENT	579	0.007	0.000	0.058	$INTAN^A$	579	0.114	0.035	0.174

This table presents the mean, median and standard deviation of variables based on the full sample of 1,035 mergers in Panel A and based on the subsample of 579 mergers in which targets have no patents during 20 years prior to the merger in Panel B. ACAR/TCAR/SYN is the acquirer's, target's, or both firms' weighted average three-day cumulative abnormal return around the deal announcement. ADJ_ACAR and ADJ_SYN are the acquirer's or the combined firm's change in wealth adjusted for industry shocks, partial anticipation, and signals about the acquirer's standalone valuation. WDADJ_ACAR and WDADJ_SYN are the acquirer's or the combined firm's change in wealth, adjusted based on the estimated synergy losses in exogenously withdrawn deals. PREMIUM is the initial offer price or the final offer price if the initial offer price is missing, divided by the target's stock price two months prior to deal announcement, minus one. TGAIN is the dollar gain of the target (i.e., target's market cap × TCAR) minus the dollar gain of the acquirer (acquirer's market cap × ACAR), divided by the sum of the acquirer's and target's market capitalization two months prior to the deal announcement. GOODWILL/IPR&D/TECH/RIGHTS/CLIENTS/TRADEMARK/INT_OTHER is the fair value of goodwill, in-process R&D, technologies, legal rights, client relationships, trademarks, or other intangible assets divided by the deal value. TECH and IPR&D are decomposed to the patented and unpatented components based on 20 years prior to the merger and please refer to the methodology described in Section 3.2. For the subsample of 579 mergers in which targets have no patents during 20 years prior to the merger, the fraction of the purchase price allocated to technology and in-process R&D are all attributable to TECH_UNPATENT and IPRD_UNPATENT. RELATIVESIZE is the deal value divided by the acquirer's market capitalization two months prior to the deal announcement. TENDER equals one for mergers involving a tender offer. DIVERSIFY equals one if the acquirer's and target's primary two-digit SIC codes differ. $SIZE^A$ is the natural logarithm of the acquirer's market capitalization (in thousands) two months prior to the deal announcement. BTM^A is the acquirer's book-to-market ratio in the end of the fiscal year prior to the deal announcement. TAX^A is the amount of total net operating loss carryovers by the acquirer in the year prior to the deal. $RUNUP^T$ is the target's abnormal buy-and-hold return measured over the one-year period ending two-months before the deal announcement. $CAPRD^A$ is the acquirer's capitalized R&D prior to the merger. $CAPADV^A$ is the acquirer's capitalized advertising expenditures prior to the merger. $INTAN^A$ is the acquirer's recognized intangible assets in the balance sheet prior to the merger. All variables are winsorized at the first and 99th percentile due to potential data errors. Please refer to Appendix 3 for detailed variable definitions

average acquirer return of −2.1% within a five-day window is documented by Cai and Sevilir (2012, p. 334). The target wealth effect, measured as the target's three-day cumulative abnormal return around the deal announcement (TCAR), and estimated synergy gains, measured as the combined firm's three-day cumulative abnormal return around the deal announcement (SYN), are both positive, representing 25.5% (median: 20.8%) of the target's market value and 2.5% (median: 1.5%) of the combined pre-merger market values. The target wealth effect comports with the 19.8% reported by Ahern (2012, p. 537) and the 21.2% reported by Cai and Sevilir (2012, p. 334). However, our estimated synergy gains are an order of magnitude greater than the 1.4% and 1.1% reported by Moeller et al. (2004, p. 224) and Cai and Sevilir (2012, p. 534), respectively. The premium paid for the target, calculated relative to the target's market value two months prior to deal announcement, averages approximately 38%.

In addition to the conventional measures of wealth effects, as described in Appendix 2, we develop alternative wealth estimates. ADJ_ACAR and ADJ_SYN are the acquirer's or the combined firm's change in wealth adjusted for industry shocks, partial anticipation, and signals about the acquirer's standalone valuation. WDADJ_ACAR and WDADJ_SYN are the acquirer's or the combined firm's change in wealth adjusted for the estimated synergy losses in exogenously withdrawn deals. Based on ADJ_ACAR and ADJ_SYN, we find that acquirer shareholders gain 0.2% and merger synergies average 3.6%. When adjusting based on synergy losses in exogenously withdrawn deals (WDADJ_ACAR and WDADJ_SYN), we find that acquirer shareholders gain 4.2% and merger synergies average 6.9%. TGAIN is the relative gain to the target firm and has an average of 0.043, indicating that, for each dollar of combined pre-merger values, targets gain 4.3 cents more than acquirers do.

In terms of purchase price allocations, we find that the allocation to goodwill (GOODWILL) accounts for 42.9% of the deal value, followed by the allocation to net tangible assets at 38.6% of the deal value as reported in Panel A of Table 2. Our focus is on the remaining 18.5% of the deal value attributable to the acquired intangible assets, such as in-process R&D, representing 2.2% of the deal value, technologies (TECH, 3.2%), trademarks (TRADEMARK, 1.7%), client relationships (CLIENTS, 3.5%), legal rights (RIGHTS, 0.7%), and a group of unspecified intangibles that are typically disclosed as "other" (INT_OTHER, 7.3%). These intangible assets are of particular interest because market participants likely have limited information about their fair values prior to the merger announcement.

We further decompose the allocation to technology (TECH) or in-process R&D into patented and unpatented components, based on the method described in Section 3.2, using the 20 years prior to the merger to identify the target's patent stock. Patented technologies (TECH_PATENT) account for 0.2% of the deal value, and unpatented technologies (TECH_UNPATENT) account for 3.0% of the deal value. Patented in-process R&D (IPRD_PATENT) accounts for 0.2% of the deal value and unpatented in-process R&D (IPRD_UNPATENT) accounts for 2.1% of the deal value. Interestingly, these statistics suggest that the majority of acquired intellectual property pertains to unpatented innovations.

Because the industry-based decomposition estimates are subject to measurement error, we turn to a subsample of 579 deals with targets that have no patents approved during the 20 years prior to the merger. Because these targets did not own any patents, the fraction of the purchase price allocated to technology and in-process R&D is fully attributable to the unpatented innovations, TECH_UNPATENT and IPRD_UNPATENT (i.e., TECH equals TECH_UNPATENT and IPR&D equals IPRD_UNPATENT). Importantly, this identification of unpatented innovation does not require any estimation and provides an excellent opportunity to examine the relation between unpatented innovation and merger wealth effects. Table 2, Panel B, reports descriptive statistics for the variables in this subsample of 579 deals. Unpatented technologies (TECH_UNPATENT) account for 0.8% of the deal value, and unpatented in-process R&D (IPRD_UNPATENT) accounts for 0.7% of the deal value. On average, acquirers lose (targets gain) -0.9% (23.9%) of their market value, and synergy gains average 2.7% of the combined merger value, with targets gaining on average 4.1 cents more than acquirers for each dollar of combined pre-merger market values. These average wealth effects are consistent with those obtained in the full sample of 1035 deals.

4.3 Subsample of mergers in which targets have no patents prior to the merger

In this section, we examine a subsample of mergers in which targets did not have any patents approved during the 20 years prior to the merger. Because targets do not own any patents, the fraction of the purchase price allocated to technology and in-process R&D is fully attributable to unpatented innovation, under the variable names TECH_UNPATENT and IPRD_UNPATENT. As this approach relies on only the counts of patents, it is less subject to measurement error. We then estimate the regression model described in Section 3.1 and Eq. (2).

Table 3, Model (1), examines SYN, the three-day cumulative abnormal return of a value-weighted portfolio of the acquirer and the target around the deal announcement. Model (2) examines ACAR, the acquirer's three-day cumulative abnormal return around the deal announcement. Model (3) examines the target's PREMIUM, measured as the initial offer price relative to the target's stock price two months prior to deal announcement. Model (4) examines TGAIN, the dollar gain of the target relative to that of the acquirer. The wealth measure in Model (5) is ADJ_SYN, the combined firm's change in wealth adjusted for industry shocks, partial anticipation, and signals about the acquirer's standalone valuation. Model (6) examines WDADJ_SYN, the combined firm's change in wealth, adjusted based on the estimated synergy losses in exogenously withdrawn deals. Model (7) examines ADJ_ACAR, the acquirer's change in wealth

Table 3 Wealth Effects in Mergers in which Targets Have No Patents

Model:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Wealth measure:	**SYN**	**ACAR**	**PREMIUM**	**TGAIN**	**ADJ_SYN**	**WDADJ_SYN**	**ADJ_ACAR**	**WDADJ_ACAR**
TECH_UNPATENT	0.20 **	0.21 **	−1.05 **	−0.11 *	0.21 **	0.20 **	0.21 **	0.21 **
IPRD_UNPATENT	0.02	−0.01	0.02	0.02	0.02	0.01	−0.01	−0.02
TRADEMARK	0.04	0.08	−0.48 **	−0.03	0.03	0.01	0.07	0.07
CLIENTS	−0.04	−0.05	0.16	0.00	−0.05	−0.03	−0.05	−0.04
RIGHTS	0.14	0.17	0.32	−0.14	0.15	0.11	0.20	0.16
GOODWILL	0.01	−0.01	0.11 *	0.03 **	0.00	0.01	−0.02	−0.01
INT_OTHER	0.06	0.03	0.04	0.04	0.06	0.06	0.03	0.02
RELATIVESIZE	0.02 ***	0.00	−0.07 ***	0.02 ***	0.02 ***	0.01 **	0.00	0.00
TENDER	0.03 **	0.04 ***	−0.08	−0.03 ***	0.03 **	0.03 **	0.04 ***	0.04 ***
DIVERSIFY	−0.01 *	−0.01 *	0.01	0.01	−0.01	−0.01 *	−0.01 *	−0.01 **
$SIZE^{A}$	−0.01 ***	0.00	−0.04 ***	0.00 ***	−0.01 ***	−0.01 ***	0.00	0.00
BTM^{A}	−0.01	0.00	−0.14 **	0.00	−0.01	−0.01	0.01	0.00
TAX^{A}	0.00	0.00	0.00	0.00 *	0.00	0.00	0.00	0.00
$RUNUP^{T}$	−0.03 **	0.01	0.54 ***	−0.05 ***	−0.03 **	−0.03 *	0.01	0.01
$CAPRD^{A}$	−0.22 **	−0.14	0.01	−0.02	−0.20 **	−0.22 **	−0.12	−0.12
$CAPADV^{A}$	0.24	0.13	1.79	0.13	0.29	0.08	0.22	0.01
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster by acquirer	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	579	579	552	579	579	523	579	523

Table 3 (continued)

Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Wealth measure:	SYN	ACAR	PREMIUM	TGAIN	ADJ_SYN	WDADJ_SYN	ADJ_ACAR	WDADJ_ACAR
Adj. R-squared	0.234	0.108	0.254	0.184	0.211	0.303	0.099	0.321

This table presents results from ordinary least squares regressions of merger wealth effects based on a subsample of 579 deals with targets that have no patents approved in the 20 years prior to the merger. Because targets did not own patents, the fraction of the purchase price allocated to technology and in-process R&D are all attributable to TECH_UNPATENT and IPRD_UNPATENT. The wealth measure in Model (1) is SYN the three-day cumulative abnormal return of a value-weighted portfolio of the acquirer and the target around the deal announcement. Model (2) examines ACAR the acquirer's three-day cumulative abnormal return around the deal announcement. Model (3) examines PREMIUM, measured as the initial offer price or the final offer price if the initial offer price is missing, divided by the target's stock price two months prior to deal announcement, minus one. Model (4) examines TGAIN, the dollar gain of the target (i.e., target's market cap × TCAR) minus the dollar gain of the acquirer (acquirer's market cap × ACAR), divided by the sum of the acquirer's and target's market capitalization two months prior to the deal announcement. Models (5) and (7) examine ADJ_SYN and ADJ_ACAR, the combined firm's or the target's change in wealth adjusted for industry shocks, partial anticipation, and signals about the acquirer's standalone valuation. Models (6) and (8) examine WDADJ_SYN and WDADJ_ACAR, the combined firm's or the acquirer's change in wealth adjusted based on the estimated synergy losses in exogenously withdrawn deals. All variables are winsorized at the first and 99th percentile due to potential data errors. Standard errors are clustered by 429 unique acquirers. *, **, *** represent significance levels of 10%, 5%, and 1%, two-tailed, under the assumption of a single hypothesis test. Please refer to Appendix 3 for detailed variable definitions.

adjusted for industry shocks, partial anticipation, and signals about the acquirer's standalone valuation. The wealth measure in Model (8) is WDADJ_ACAR, the acquirer's change in wealth adjusted based on the estimated synergy losses in exogenously withdrawn deals.

We find that TECH_UNPATENT is positively associated with merger synergy (Model 1: *p* value of 0.02) and positively associated with acquirer wealth changes (Model 2: p value of 0.01). However, TECH_UNPATENT is negatively associated with target wealth changes (Model 3: p value of 0.04) and negatively associated with the dollar gain of the target, relative to that of the acquirer (Model 4: p value of 0.09). We view these results as consistent with the arguments developed in Section 2.4 about the relative bargaining power of the acquirer and the target when public information about the target's innovation is limited.

The relation between unpatented technologies and merger synergy gains is also economically significant. When evaluated at the mean, TECH_UNPATENT contributes approximately 6% to synergy gains. An alternative way to evaluate the economic magnitude is to adjust all regressors to have a mean of zero, except for the variable of interest, and compare the intercept magnitude to the mean of SYN, which is 2.7%. For example, the intercept is 2.5% when all regressors have a zero mean, except for TECH_UNPATENT and IPRD_UNPATENT. Therefore, we interpret that unpatented innovation is associated with 7.4% of the sample average merger synergy, calculated as (2.7–2.5)/2.7. These statistics illustrate the importance of unpatented innovation in merger value creation, which research overlooks by focusing mostly on pre-merger patents.

When using alternate synergy measures that adjust for the endogenous nature of merger announcement returns, we continue to find that TECH_UNPATENT is positively associated with synergy gains (Model 5 ADJ_SYN: *p* value of 0.03, Model 6 WDADJ_SYN: p value of 0.02) and is positively associated with the acquirer's wealth (Model 7 ADJ_ACAR: p value of 0.02, Model 8 WDADJ_ACAR: p value of 0.01). Results reported Table 3 are robust to using only the three years prior to the merger to identify the subsample of targets with no patents, suggesting that these results are not only driven by older patents. For example, TECH_UNPATENT is positively associated with synergy gains (SYN, p value of 0.02), positively associated with the acquirer's wealth (ACAR, p value of 0.01), and negatively associated with the target's wealth (PREMIUM, p value of 0.07). Overall, our subsample analysis identifies unpatented technologies that are less subject to measurement error and highlights the important relationship of the less examined unpatented component of innovation with merger value creation. Moreover, the positive acquirer wealth effects are consistent with greater bargaining power of acquirers, which, as discussed before, could result to the release of proprietary information on part of targets or their own pre-merger information gathering (e.g., Higgins and Rodriguez 2006).

4.4 Merger wealth effects in the full sample

We next turn to our full sample of 1035 mergers and rely on the industry-based methodology of Glaeser et al. (2020) to decompose the amount of the purchase price allocated to technology and in-process R&D separately into a patented component and a residual, unpatented component, as described in Section 3.2. Although the estimation procedure may introduce some measurement error in the decomposition, the greater sample size allows us to estimate the relative importance of unpatented innovation versus patented innovation in a broader sample of deals.

Table 4 examines merger synergy, measured as SYN in Models (1)–(3), ADJ_SYN in Model (4), and WDADJ_SYN in Model (5). As a benchmark model, Model (1) includes three deal characteristics, seven firm characteristics, and year and industry fixed effects. These determinants explain approximately 19.1% of the variation in SYN. Model (2) further includes the scaled fair values of the seven acquired intangible asset categories, using the scaled fair value of net tangible assets as the reference category. The adjusted R^2 increases to 20.3%, suggesting that the various types of intangible assets have explanatory power for merger synergies. We find that technology (TECH), in-process R&D (IPR&D), and other intangible assets (INT_OTHER) are positively related to merger synergies, while client relationships (CLIENTS) are negatively associated with synergies. When evaluated at the mean, TECH represents 10% of the synergy, IPR&D represents 5%, and INT_OTHER represents 11% of synergies, while CLIENTS is associated with a synergy reduction of 8%.

More importantly, Model (3) presents results based on our decomposed patented and unpatented forms of innovation. Specifically, we replace the scaled fair values of technology (TECH) and in-process R&D (IPR&D) with the decomposed patented and unpatented counterparts, scaled by the deal value.

We find that both TECH_UNPATENT and IPRD_UNPATENT are positively associated with merger synergy, both with a p value of 0.02, while the patented counterparts (TECH_PATENT and IPRD_PATENT) are not significantly associated with merger synergy in Table 4.[24] When evaluated at their respective means, TECH_UNPATENT and IPRD_UNPATENT contribute approximately 8.7 and 4.3% to merger synergies, while TECH_PATENT and IPRD_PATENT each contributes less than 2% to synergy gains. Similarly, the mean-adjusted regressions suggest that TECH_UNPATENT (IPRD_UNPATENT) contributes approximately 6 (3) percent to the sample average synergy, whereas TECH_PATENT and IPRD_PATENT each contributes less than 1%. When examining the adjusted synergy measures (ADJ_SYN and WDADJ_SYN) in Models (4) and (5), we consistently find that TECH_UNPATENT and IPRD_UNPATENT are significantly associated with merger synergy (all p values less than 0.02), while TECH_PATENT and IPRD_PATENT do not present a significant association. As the coefficients of patented and unpatented technologies are not significantly different, these results suggest that there is no difference in merger value creation per unit of patented or unpatented innovation but that the greater amount of unpatented innovation makes its relative contribution to merger synergies larger.

[24] Patenting innovation is a disclosure decision, and, for all the period covered by our sample, those disclosures are substantial. That is, our sample period from 2001 to 2015 occurs after the passage of the 2000 American Inventor's Protection Act, which requires inventors to publicly disclose patent applications upon filing, regardless of whether the application would eventually be granted. Hence investors have detailed information about the nature of patented innovation, and we conjecture that the market value of the target's equity reflects much of the value of the patented innovation. As such, the insignificant association between patented innovation and merger synergies could result from the fact that the merger announcement does not significantly revise investors' expectations about the value of the patented innovation.

Table 4 Merger Synergy in the Full Sample

Model:	(1)	(2)	(3)	(4)	(5)
Wealth measure:	**SYN**	**SYN**	**SYN**	**ADJ_SYN**	**WDADJ_SYN**
TECH_PATENT			0.12	0.15	0.12
TECH_UNPATENT			0.07 **	0.08 **	0.08 **
IPRD_PATENT			0.21	0.22	0.22
IPRD_UNPATENT			0.05 **	0.06 **	0.06 ***
TECH		0.08 **			
R&D		0.06 **			
TRADEMARK		0.03	0.03	0.04	0.02
CLIENTS		−0.06 **	−0.06 *	−0.06 **	−0.06 *
RIGHTS		0.10	0.09	0.08	0.11
GOODWILL		0.01	0.01	0.01	0.01
INT_OTHER		0.04 *	0.04 *	0.04 *	0.04 *
RELATIVESIZE	0.02 ***	0.02 ***	0.02 ***	0.02 ***	0.02 ***
TENDER	0.01 ***	0.01 **	0.01 **	0.01 **	0.01 **
DIVERSIFY	−0.01 *	−0.01 *	−0.01 *	−0.01	−0.01
SIZEA	−0.01 ***	−0.01 ***	−0.01 ***	−0.01 ***	−0.01 ***
BTMA	−0.02 **	−0.02 **	−0.02 **	−0.03 ***	−0.02 ***
TAXA	0.00	0.00	0.00	0.00	0.00
RUNUPT	−0.02 **	−0.02 **	−0.02 **	−0.02 **	−0.02 *
CAPRDA	−0.14 ***	−0.17 ***	−0.18 ***	−0.17 ***	−0.20 ***
CAPADVA	0.31	0.25	0.22	0.25	0.13
INTANA	−0.01	−0.01	−0.01	−0.01	−0.02
N	1035	1035	1035	1035	942
Adj. R-squared	0.191	0.203	0.203	0.185	0.317
p value for H0: TECH_PATENT = TECH_UNPATENT					
			0.133	*0.101*	*0.097*
p value for H0: IPRD_PATENT = IPRD_UNPATENT					
			0.243	*0.246*	*0.221*

This table presents results from ordinary least squares regressions of merger synergy, measured as SYN the three-day cumulative abnormal return of a value-weighted portfolio of the acquirer and the target around the deal announcement in Models (1)–(3), as ADJ_SYN the combined firm's change in wealth adjusted for industry shocks, partial anticipation, and signals about the acquirer's standalone valuation in Model (4), and as WDADJ_SYN the combined firm's change in wealth adjusted based on the estimated synergy losses in exogenously withdrawn deals in Model (5). Model (1) includes three deal characteristics, seven firm characteristics, year and industry fixed effects. Model (2) further includes the scaled fair values of seven acquired intangible asset categories, using net tangible assets as the reference category. Models (3)–(5) replace the scaled fair value of technology (TECH) and in-process R&D with the decomposed patented and unpatented estimates. The decomposed estimates are based on target's patent stock during 20 years prior to the merger. Please refer to Section 3.2 for the decomposition methodology. We include year fixed effects and industry fixed effects based on the acquirer's Fama-French 12 industry classification. All variables are winsorized at the first and 99^{th} percentile. Standard errors are clustered by 748 unique acquirers. *, **, *** represent significance levels of 10%, 5%, and 1%, two-tailed, under the assumption of a single hypothesis test. Please refer to Appendix 3 for detailed variable definitions.

Overall, the synergy results in the full sample further illustrate the importance of unpatented innovation, and they suggest that research had underestimated the contribution of innovation to merger synergies, as both unpatented technologies and unpatented in-process R&D are positively associated with merger synergies. A potential explanation for the stronger results for in-process R&D in the full sample is that the no-patent sample is composed of firms that rely less heavily on R&D.

Next, we examine the acquirer's and target's wealth effects in Table 5. Model (1) examines ACAR, Model (2) examines ADJ_ACAR, Model (3) examines WDADJ_ACAR, Model (4) examines PREMIUM, and Model (5) examines TGAIN. We find that TECH_UNPATENT is positively associated with the acquirer's wealth across all three measures in Models (1)–(3), with all *p* values being less than 0.02. Also, TECH_UNPATENT is negatively associated with the target's wealth as reflected by the negative coefficient on TGAIN (p value of 0.06 in Model (5)). In contrast, we do not find consistent results for IPRD_UNPATENT, as there is no association with the acquirer wealth effects and a positive association with the target's wealth measured by PREMIUM in Model (4) but no relation with the relative gain of the target (TGAIN) in model (5). At a minimum, these results suggest that the stronger bargaining power of the acquirer for unpatented technologies is not present for unpatented in-process R&D. A potential explanation is that proprietary costs are more pronounced for finished projects (unpatented technologies) that are directly implementable by the acquirer, as opposed to unfinished in-process R&D projects that would still require a considerable time and financial investment on part of the acquirer.

In addition, trademarks present a weak and positive association with the acquirer's wealth, and client relationships presents a weak and negative association with the acquirer's wealth. Lastly, goodwill is positively associated with the target's gain, measured as PREMIUM in Model (4) with a p value of 0.07 or as TGAIN in Model (5) with a p value less than 0.01. However, patented innovations (TECH_PATENT and IPRD_PATENT) are not significantly associated with the acquirer's or target's wealth creation.[25]

The full sample results in Table 5 are robust to decomposing the value of acquired innovation-related assets into patented and unpatented components, using patent market values from Kogan et al. (2017). Specifically, we subtract the full amount of the estimated market values based on the approval date market reactions from the Kogan et al. (2017) database from the fair values of the acquired technologies and in-process R&D and assume the remaining amount to be unpatented innovation. This estimation approach complements the industry-based regression estimation methodology described in Section 3.2. Importantly, we continue to find that unpatented technologies and in-process R&D are positively associated with merger synergy (SYN, p values less than 0.01) and, in the case of technologies, positively associated with the acquirer's wealth (ACAR, p value of 0.07).

Furthermore, as a robustness test (available on request), we expand the announcement event window to up to 10 days before the announcement [−10, +1] to allow for information leakage or deal anticipation (Hoberg and Phillips 2010). We continue to

[25] Given that our regression analyses use acquired net tangible assets as the benchmark group, these results do not indicate that purchasing patented innovation does not create value. Rather, they suggest that there is no difference in value creation from acquiring patented innovation, relative to value creation from acquiring net tangible assets.

Table 5 Acquirer's and Target's Changes in Wealth in the Full Sample

Model: **Wealth measure:**	**(1)** **ACAR**	**(2)** **ADJ_ACAR**	**(3)** **WDADJ_ACAR**	**(4)** **PREMIUM**	**(5)** **TGAIN**
TECH_PATENT	−0.02	0.02	0.00	0.75	0.13
TECH_UNPATENT	0.10 ***	0.10 **	0.10 ***	−0.20	−0.06 *
IPRD_PATENT	0.28	0.24	0.27	0.83	−0.22
IPRD_UNPATENT	0.02	0.02	0.02	0.49 ***	0.02
TRADEMARK	0.07 *	0.08 *	0.07	−0.19	−0.04
CLIENTS	−0.06 *	−0.07 *	−0.06	0.04	0.04
RIGHTS	0.07	0.07	0.10	0.17	−0.03
GOODWILL	−0.01	−0.02	0.00	0.09 *	0.03 ***
INT_OTHER	0.02	0.03	0.02	0.12	0.02
RELATIVESIZE	0.00	0.00	0.00	−0.05 ***	0.03 ***
TENDER	0.01 **	0.01 **	0.01 **	0.04	−0.01
DIVERSIFY	−0.01	−0.01	−0.01	0.00	0.00
$SIZE^{A}$	0.00	0.00	0.00	−0.02 ***	0.00 ***
BTM^{A}	−0.01	−0.02 *	−0.01	−0.06	0.01
TAX^{A}	0.00	0.00	0.00	0.00	0.00
$RUNUP^{T}$	0.02 *	0.02	0.02	0.51 ***	−0.05 ***
$CAPRD^{A}$	−0.17 ***	−0.15 ***	−0.17 ***	−0.26	0.09 **
$CAPADV^{A}$	0.08	0.11	−0.02	2.06 *	−0.01
$INTAN^{A}$	0.00	−0.01	0.00	0.07	−0.02
N	1035	1035	942	984	1035
Adj. R-squared	0.084	0.070	0.314	0.197	0.175
p value for H0: TECH_PATENT = TECH_UNPATENT	*0.612*	*0.479*	*0.438*	*0.308*	*0.509*
p value for H0: IPRD_PATENT = IPRD_UNPATENT	*0.246*	*0.309*	*0.254*	*0.351*	*0.200*

This table presents results from ordinary least squares regressions of the acquirer's change in wealth, measured as ACAR in Model (1), as ADJ_ACAR in Model (2), or as WDADJ_ACAR in Model (3). ACAR is the acquirer's three-day cumulative abnormal return around the deal announcement. ADJ_ACAR adjusts for industry shocks, partial anticipation, and signals about the acquirer's standalone valuation. WDADJ_ACAR is based on the estimated synergy losses in exogenously withdrawn deals. Model (4) examines PREMIUM, measured as the initial offer price or the final offer price if the initial offer price is missing, divided by the target's stock price two months prior to deal announcement, minus one. The wealth measure in Model (5) is TGAIN the dollar gain of the target (i.e., target's market cap × TCAR) minus the dollar gain of the acquirer (acquirer's market cap × ACAR), divided by the sum of the acquirer's and target's market capitalization two months prior to the deal announcement. The decomposed patented and unpatented estimates are based on target's patent stock during 20 years prior to the merger. We include year fixed effects and industry fixed effects based on the acquirer's Fama-French 12 industry classification. All variables are winsorized at the first and 99th percentile. Standard errors are clustered by unique acquirers. *, **, *** represent significance levels of 10%, 5%, and 1%, two-tailed, under the assumption of a single hypothesis test. Please refer to Appendix 3 for detailed variable definitions find a positive association between unpatented innovation and merger synergy. Overall, taking results from all analyses together, we find that unpatented innovation is an important source of merger synergy and significantly impacts the merging firms' shareholders' wealth.

4.5 Post-merger profitability

After examining the expectations of merger synergies around deal announcements, we further investigate whether the acquisition of innovation affects post-merger profitability. Following Hoberg and Phillips (2010), we focus on profitability, measured as returns on assets. We use bottom-line earnings (i.e., earnings before extraordinary items from Compustat) to incorporate impairments of acquired assets, as they are often included in special items below the operating income line. Because both merger decisions and innovation investment decisions are driven by endogenous economic factors that are unobservable to researchers, we follow Bena and Li (2014) and use mergers for withdrawn for reasons exogenous to innovation as a quasi-experiment. Specifically, we identify 74 withdrawn mergers announced between 2001 and 2015 involving publicly listed acquirers and targets from the SDC database. Based on the list of exogenous reasons in Table 1 of Savor and Lu (2009), we identify 26 withdrawn mergers as the control group. We examine a baseline model using the following specification.

$$\mathrm{ROA}_{i,t} = \alpha_1\ \mathrm{After}_{i,t} + \alpha_2\ \mathrm{Treat}_{i,t} + \alpha_3\ \mathrm{After} \times \mathrm{Treat}_{i,t} + \sum y_t \mathrm{Year}_t + \sum d_n \mathrm{Industry}_n + \varepsilon_{i,t}. \tag{5}$$

The firm-year panel includes three years before the merger announcement (After = 0) and three years after the merger completion or withdrawal date (After = 1). Pre-merger ROA is the sum of the acquirer's and the target's incomes before extraordinary items divided by the sum of the acquirer's and the target's beginning-of-year total assets. Post-merger ROA is the combined firm's income before extraordinary items divided by beginning total assets. ROAs are winsorized at the first and 99th percentile, and standard errors are clustered by 1061 mergers. Year fixed effects are based on the year of ROA, and industry fixed effects are based on the acquirer's industry membership.

We next classify 1035 treatment mergers into innovative and non-innovative mergers, based on whether the acquirer purchases any technology or in-process R&D, according to the purchase price allocation disclosure. The expanded model is as follows.

$$\begin{aligned}\mathrm{ROA}_{i,t} = {} & \alpha_4\ \mathrm{After}_{i,t} + \alpha_5\ \mathrm{Non{-}Innovative\ Treat}_{i,t} + \alpha_6\ \mathrm{Innovative\ Treat}_{i,t} \\ & + \alpha_7\ \mathrm{After} \times \mathrm{Non{-}Innovative\ Treat}_{i,t} + \alpha_8\ \mathrm{After} \times \mathrm{Innovative\ Treat}_{i,t} \\ & + \sum y_t \mathrm{Year}_t + \sum d_n \mathrm{Industry}_n + \varepsilon_{i,t}.\end{aligned} \tag{6}$$

We further decompose the innovative treatment mergers into patented and nonpatented subgroups, depending on whether the target owns at least one patent during the 20 years prior to the merger announcement.

$$ROA_{i,t} = \alpha_9 After_{i,t} + \alpha_{10}\, NonInnovative\ Treat_{i,t} + \alpha_{11}\, Patent\ Innovative\ Treat_{i,t} + \alpha_{12}\, NonPatent \mathrm{Innovative\ Treat}_{i,t} + \alpha_{13}\, \mathrm{After} \times \mathrm{NonInnovative\ Treat}_{i,t} + \alpha_{14} \mathrm{After} \times \mathrm{Patent\ Innovative\ Treat}_{i,t} + \alpha_{15}\, \mathrm{After} \times \mathrm{NonPatent\ Innovative\ Treat}_{i,t} + \sum y_t \mathrm{Year}_t + \sum d_n \mathrm{Industry}_n + \varepsilon_{i,t}. \quad (7)$$

Model (1) of Table 6 shows that, on average, the treatment (completed) mergers have lower profitability during the post-merger period than the control (withdrawn) mergers. When decomposing completed mergers into two groups in Model (2), we find that the lower post-merger profitability is driven by non-innovative mergers rather than innovative mergers. (*p* value for the difference in coefficients between innovative and non-innovative completed mergers is 0.035.) In other words, mergers acquiring innovation do not have differential profitability from withdrawn mergers, but mergers that do not acquire innovation have lower profitability after merger completion. This finding is consistent with our announcement results that show that innovation is positively associated with value creation. Finally, in Model (3), we do not find that patented and nonpatented innovations have a differential impact on post-merger profitability, again consistent with our announcement results.

Following Bena and Li (2014), we further conduct falsification tests that assume three or four years before the actual merger announcement, completion, or withdrawn dates in Models (4)–(9) of Table 6. None of the variables has a significant coefficient, except for nonpatent innovative treatment merging firms, which show lower profitability before mergers, a finding in line with the potential motivation of acquirers to seek targets (e.g., Wang 2018). Overall, the post-merger profitability analysis presents consistent evidence that innovation creates value.

4.6 Additional validation tests

4.6.1 When do investors know about fair values of acquired intangible assets?

Although the official disclosure of the purchase price allocation is filed with the SEC on average 221 days after the merger announcement (see Fig. 2), we argue that most (qualitative) information regarding the fair values of acquired intangible assets has been released around merger announcements. To validate this assumption, in untabulated analyses, we find that the market-adjusted three-day equity market reaction to the initial SEC 10-K filing that contains the purchase price allocation disclosure is only 0.0014. After removing 102 PPA disclosure SEC filing dates that are confounded with quarterly earnings announcements, the average market-adjusted three-day market reaction declines to only 0.0002.[26] Such a small magnitude, especially compared to the reaction to initial merger announcements, suggests that there is limited new information contained in the official SEC filing.[27] Moreover, when we regress merger

[26] To address the concern that investors may need time to read the lengthy 10-K filings, we extend the event window up to 21 days around the 10-K filings and obtain a similar magnitude of market reaction across different event windows.

[27] Our finding of insignificant market reaction is consistent with the evidence of Shalev (2009) but conflicts with the evidence of Paugam et al. (2015).

Table 6 Post-Merger Profitability

Model:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
Merger announcement:	**Actual date**			**Assume three years before the actual date**			**Assume four years before the actual date**		
After	0.03	0.03	0.03	0.00	0.00	0.00	0.01	0.01	0.01
Treat	−0.01			−0.01			0.00		
After × Treat	−0.04 **			0.00			−0.01		
Non-Innovative Treat		−0.01	−0.01		−0.01	−0.01		0.00	0.00
Innovative Treat		−0.02			−0.02			−0.01	
After × Non-Innovative		−0.05 **	−0.05 **		−0.01	−0.01		−0.01	−0.01
After × Innovative		−0.03			0.00			−0.01	
Patent Innovative Treat			−0.02			−0.01			0.00
Non-Patent Innovative Treat			−0.05 **			−0.06 *			−0.04
After × Patent			−0.03			0.00			−0.01
After × Non-Patent			−0.03			0.01			0.00
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster by Deal	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	6041	6041	6041	6008	6008	6008	5856	5856	5856
Adj. R-squared	0.059	0.060	0.066	0.049	0.050	0.052	0.040	0.040	0.052
p value for H0: After × Non-Innovative = After × Innovative		*0.035*			*0.882*			*0.527*	
p value for H0: After × Patent = After × Non-Patent		*0.128*			*0.784*			*0.707*	

This table presents results from ordinary least squares regressions on returns on assets (ROA). The sample includes 1035 completed mergers examined in Tables 4–5 (Treat = 1) and 26 withdrawn mergers (Treat = 0) for reasons exogenous to innovation. The firm-year panel includes three years before the merger announcement (After = 0) and three years after the merger completion or withdrawn date (After = 1). The pre-merger ROA is the sum of the acquirer's and the target's incomes before extraordinary items divided by the sum of the acquirer's and the target's beginning of the year total assets. The post-merger ROA is the combined firm's income before extraordinary items divided by beginning total assets. We classify 1035 treatment mergers into innovative and non-innovative mergers, based on whether the acquirer purchases any technology or in-process R&D. We further decompose the innovative treatment mergers into the patent and nonpatent subgroups, depending on whether the target owns at least one patent during the 20 years before the merger announcement. Models (1)–(3) rely on the actual merger announcement, completion, or withdrawn dates to identify the pre- and post-merger periods. The falsification tests in Models (4)–(6) assume three years before the actual merger announcement, completion, or withdrawn dates, and Models (7)–(9) assume four years before the actual merger announcement, completion, or withdrawn dates. ROAs are winsorized at the first and 99th percentile due to potential data errors. Standard errors are clustered by 1061 mergers. Year fixed effects are based on the year of ROA, and industry fixed effects are based on the acquirer's industry membership. *, **, *** represent significance levels of 10%, 5%, and 1%, two-tailed, under the assumption of a single hypothesis test.

announcement returns on the merged firm's stock return around the SEC filing of the purchase price allocation disclosure, there is an insignificant relation, and the

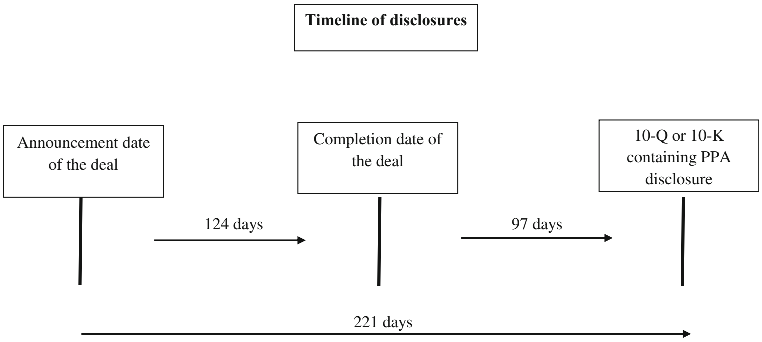

Fig. 2 This figure reports the timeline of the typical deal in our sample. After the deal is initially announced, it takes on average 124 days for completion (median: 107 days). After completion, it takes on average 97 days for the purchase price allocation to be officially disclosed in a SEC filing, in either a Form 10-Q or 10-K, whichever comes first (median: 91 days). There is an average of 221 days (median: 207 days) between the initial announcement of the deal and the initial SEC filing containing the PPA disclosure

correlation level is only 0.06 or 0.08. This result further supports the notion that investors do not wait until the SEC filings that contain the purchase price allocation disclosure to learn about the sources of synergy derived from the acquired assets.

If investors indeed learn about qualitative information about sources of synergy with respect to values of acquired assets, merger announcement conference calls serve a publicly observable venue. We identify 354 merger-announcement conference-call transcripts, which are conditional on merging firms choosing to host a conference call (see Kimbrough and Louis 2011 for an examination of this choice) and conditional on a hosted conference call being transcribed either by the hosting firms or by a third-party vendor. We rely on the Stanford Named Entity Recognizer to identify specific locations, organizations, persons, money, percentages, times, dates and then calculate the ratio of words in specific terms to total words in a conference call's question-and-answer (Q&A) session. We sort transcripts into three groups based on the specificity ratio for each year and create an indicator variable SPECIFIC that equals one for mergers for which specificity ratios fall in the highest tercile. We interact this SPECIFIC indicator variable with the intangible allocation variables (TECH, IPR&D, TRADEMARK, CLIENTS, RIGHTS, GOODWILL, and INT_OTHER) to examine whether qualitative discussions during conference-call Q&As help investors understand the sources of synergy related to the intellectual property or other intangible assets.

We find that the positive relationship between in-process R&D and merger synergy (SYN) is stronger for merger conference calls with more specific details. (The p value for the coefficient of IPR&D × SPECIFIC is less than 0.01.) We also find a significant and positive coefficient for CLIENTS×SPECIFIC (p value<0.01) and for INT_OTHER×SPECIFIC (p value = 0.02). These findings suggest that detailed information about sources of synergies related to acquired intangible assets is potentially released at merger initial announcements, rather than delayed until the SEC filing that contains the mandated purchase price allocation disclosure.

4.6.2 Reporting bias in the purchase price allocation disclosure

Studies argue that managers may overstate the portion of the merger purchase price allocated to goodwill, because goodwill is not subject to amortization and can lead to temporarily overstated post-merger earnings (Shalev 2009; Shalev et al. 2013; and Zhang and Zhang 2017). We follow Shalev et al. (2013) and use the ratio of an acquirer CEO's cash bonus to her annual total compensation as a proxy for the incentive to manipulate the purchase price allocation disclosure. After merging our sample with the ExecuComp database to obtain compensation data, our sample reduces to 670 deals, because ExecuComp covers only the S&P 1500 firms. We sort mergers into three groups, based on the CEO bonus ratio for each year, and create an indicator variable CEO_BONUS that equals one for mergers in which the bonus ratio falls in the highest tercile. We interact this variable with the intangible allocation variables (TECH, IPR&D, TRADEMARK, CLIENTS, RIGHTS, GOODWILL, and INT_OTHER) to examine whether the relation between the scaled fair values of intangible assets and merger wealth effects is altered when the acquirer's CEO has greater incentives to misreport the purchase price allocation. In untabulated analyses, we find that none of the interaction terms has a significant coefficient, suggesting that our previous results are unlikely to be affected by managerial incentives to misreport.

Another reporting bias specific to our study may derive from the attempt to keep the acquired innovation as a secret. Merging firms may include unpatented innovation as part of the acquired goodwill in the purchase price allocation disclosure. To examine this hypothetical manipulation, we create an indicator for 183 mergers that recognize a zero value for technologies and in-process R&D in the purchase price allocation but for which the target owned at least one patent during the 20 years prior to the merger. We interact this indicator with the scaled fair value of goodwill and augment the regression model by incorporating this interaction term. Across all merger wealth effects, we do not find that goodwill presents a differential coefficient for these 183 mergers, compared to the other deals in our sample. We fail to reject the null hypothesis that managers do not misallocate the purchase price to goodwill as an attempt to keep the acquired innovation as a secret.

5 Conclusion

Research on merger synergies and innovation has primarily focused on patents. Using a unique database of merger-specific fair values of a target's innovations from purchase price allocation disclosures, we show that the less examined unpatented innovation plays an important role. Indeed, our results on the relation between unpatented innovation and merger wealth effects show that research has underestimated the importance of innovation by only focusing on patents, and these results are consistent with the conjecture of economists, who have long recognized the limitations of using patents as proxies for innovation. Our results are especially relevant as the U.S. economy continues its transition away from manufacturing.

Our study further highlights the usefulness of the purchase price allocation disclosure from financial statements in helping researchers understand unpatented innovation, whose values are rarely observed elsewhere. Our evidence suggests that using post-merger SEC filings to extract merger-specific fair values of acquired intangible assets provides a more precise and complete representation of the acquisition of a target's innovation.

Appendix 1 Example of Purchase Price Allocation Disclosure

Oracle's Acquisition of BEA Systems

Pursuant to our business combinations accounting policy, the total purchase price for BEA was allocated to the net tangible assets, intangible assets, and in-process research and development based upon their estimated fair values as of April 29, 2008, as set forth below. The excess of the purchase price over the net tangible assets, intangible assets, and in-process research and development acquired was recorded as goodwill:

(in millions)	
Cash and marketable securities	$1,775
Trade receivables	167
Goodwill	4,355
Intangible assets	3,343
Other assets	248
Accounts payable and other liabilities	(386)
Restructuring (see Note 7)	(231)
Deferred tax liabilities, net	(551)
Deferred revenues	(164)
In-process research and development (IPR&D)	17
Total purchase price	$**8,573**

In accordance with SFAS 141, Oracle is also required to decompose the $3,343 it allocates to intangible assets:

In performing our preliminary purchase price allocation, we considered, among other factors, our intention for future use of acquired assets, analyses of historical financial performance and estimates of future performance of BEA's products. The fair values of intangible assets were calculated using an income approach and estimates and assumptions provided by both BEA and Oracle management. The rates utilized to discount net cash flows to their present values were based on our weighted average cost of capital and ranged from 7% to 17%. This discount rate was determined after consideration of our rate of return on debt capital and equity and the weighted average return on invested capital. The following table sets forth the preliminary components of intangible assets associated with the BEA acquisition:

(Dollars in millions)	Fair Value	Useful Life
Software support agreements and related relationships	1,115	8 years
Developed technology	1,118	6 years
Online Core technology	518	7 years
Customer relationships	530	8 years
Trademarks and other	62	5 years
Total intangible assets	**3,343**	

Where they continue to describe what is included in each of these categories:

> Customer relationships and software support agreements and related relationships represent the underlying relationships and agreements with BEA's customers. Developed technology is comprised of products that have reached technological feasibility and are a part of BEA's product lines. Core technology represents a combination of BEA processes, patents, and trade secrets related to the design and development of BEA's software products. This proprietary know-how can be leveraged to develop new technology and improve our existing software products. Trademarks represent the fair value of brand and name recognition associated with the marketing of BEA's products and services.

Following the methodology of our study, we would calculate the allocation to in-process R&D to be 0.20% (17/8573), the allocation to technology to be 32.09% (2751/8573), the allocation to client relationships to be 6.18% (530/8573), the allocation to trademarks to be 0.72% (62/8573), and the allocation to goodwill to be 50.80% (4355/8573), with the remainder representing tangible net assets.

Appendix 2 Adjusted Wealth Effect Estimates

Industry shocks, partial anticipation, and signals about the acquirer's standalone valuation

Synergy gains are traditionally estimated by combining acquirer and target shareholder wealth effects ($SYNERGY = \Delta MVE^{T} + \Delta MVE^{A}$), following Bradley et al. (1988), where $\Delta MVE^{T(A)}$ is the abnormal change in the target's (acquirer's) market value of equity over the three-day window surrounding the merger announcement. The target wealth effect ΔMVE^{T} is the difference between the purchase price and the target's market value of equity prior to merger announcement and can be construed as the difference between the "synergistic" value of the target as perceived by the acquirer's management and the standalone value of the target. Whereas the measurement of the target wealth effect is subject to a partial anticipation criticism (anticipation or leakage are the main reason for typically measuring the deal premium using the target's market price two months prior to deal announcement), the measurement issues at the acquirer level are more severe and include the potential confounds of overvaluation and signals of future growth opportunities. We rely on prior work to construct an alternative estimate of the effect of merger announcements on acquirer shareholders' wealth that seeks to control for the endogenous nature of acquisitions.

We adjust the stock price reaction for (i) industry shocks that often underlie merger activities (e.g., Kaplan 2000; Andrade et al. 2001), (ii) the partial anticipation of merger announcements by investors (e.g., Schipper and Thompson 1983; Song and Walking 2000; Wang 2018), and (iii) the extent to which a merger announcement reveals new information about the acquirer's standalone valuation, such as incentives to engage in acquisitions in response to overvaluation and an acquirer's limited growth opportunities (e.g., Travlos 1987; Fuller et al. 2002; McCardle and Viswanathan 1994; Moeller et al. 2004; Savor and Lu 2009). We begin by calculating abnormal returns adjusted for market and industry effects (IACAR). We estimate a bivariate market model that includes both the market return and a value-weighted Fama and French 12 industry return, over the one-year period ending two months prior to the deal announcement. Although the above abnormal return adjusts for both market and industry dynamics, we conjecture it still reflects both a signal of a firm's overvaluation and (limited) growth opportunities in addition to the net acquirer gains arising from previously unanticipated merger synergies. To separate the firm-specific signal from the actual merger gains, we estimate the following model using all public deals in the SDC database over the ten calendar years preceding the year in which a deal is announced.

$$\mathrm{IACAR}_j = a_0 + a_1\mathrm{STOCKONLY}_j + a_2\,\mathrm{TOBINSQ}_j + a_3\mathrm{SGROWTH}_j + a_4\mathrm{CASH}_j + \varepsilon_j. \tag{8}$$

For each deal *j*, STOCKONLY refers to acquisitions using stock as the only mode of payment. TOBINSQ is measured as the sum of an acquirer's market value of equity, preferred stock, and total debt, scaled by total assets in the year prior to the deal. SGROWTH is the natural logarithm of the change in sales over the year preceding the year in which the deal is announced. And CASH is the acquirer's cash balance, relative to total assets in the year prior to the deal. We include STOCKONLY as stock deals can be a signal to shareholders that the acquirer's shares are overvalued. We include TOBINSQ and SGROWTH as two measures of (declining) growth opportunities for acquirers, while higher cash balances (CASH) may indicate high agency costs. In the second step, we estimate the portion of market and industry-adjusted acquirer returns (IACAR) that is not explained by the model in Eq. (8). We estimate Eq. (8) using all deals in the SDC database during the 10 calendar years preceding the year in which a deal is announced and then use the parameter estimates and actual realizations to predict the one-year-ahead signal component in IACAR. The difference between market- and industry-adjusted acquirer returns (IACAR) and the predicted value based on Eq. (8) is our estimate of the unanticipated merger wealth effect on the acquirer of deal *j* at time $t+1$:

$$\mathrm{RES}_{jt+1} = \mathrm{IACAR}_{jt+1} - (\hat{a}_{0t} + \hat{a}_{1t}\mathrm{STOCKONLY}_{jt+1} + \hat{a}_{2t}\mathrm{TOBINSQ}_{jt+1} + \hat{a}_{3t}\mathrm{SGROWTH}_{jt+1} + \hat{a}_{4t}\mathrm{CASH}_{jt+1}). \tag{9}$$

As a final step, we obtain our new estimate of merger wealth effects by dividing RES_{jt+1} by (1- P_{jiACQ}), where P_{jiACQ} is the estimated probability that firm *i* of deal *j* is an acquirer in year $t+1$:

$$\mathrm{ADJ\_ACAR}_{\mathrm{jt+1}} = \mathrm{RES}_{\mathrm{jt+1}} / \left(1 - \mathrm{P}_{\mathrm{jiACQ}}\right). \tag{10}$$

To the extent that a transaction is anticipated, there should be no or a smaller reaction at the time of the announcement of the deal. Building on prior literature (e.g., Cremers et al. 2009; Edmans et al. 2012), we estimate the probability of acquisition (P_{jiACQ}), based on all firms with available data on Compustat and CRSP. Specifically, we regress an indicator variable for whether firm *i* is an acquirer in year *t+ 1* on the following variables in year *t* (or indicated otherwise): the number of merger deals by the firm; the number of deals in the industry; the industry Herfindahl index; an indicator for firms that did not engage in a transaction over the years *t-3* to *t-1*; an indicator for dividend-paying firms; firm size as the market value of equity; firm age based on CRSP; firm-leverage ratio; return on assets; goodwill-to-total-assets ratio; R&D-to-sales ratio; number of segments; market-adjusted return over the fiscal year; standard deviation of daily residual returns; percentage of shares owned by transient, dedicated, and index-following institutional investors; number of analysts; and TOBINSQ, CASH, and SGROWTH, as defined before. The Pseudo R^2 is 11.1%, and the predicted probability of a deal is equal to 7.5% in cases in which there is an acquisition in year *t+ 1*, compared to 3% in cases in which there is no acquisition in year *t+ 1*. Overall, these results suggest that the model performs reasonably well in predicting future acquirers and that the predicted probability can be used to adjust the observed announcement returns for (partial) anticipation.

Adjustment based on exogenously withdrawn deals

We draw from work by Savor and Lu (2009) and Wang (2018) who show that samples of withdrawn deals are useful in distinguishing between alternative explanations of the impact of mergers and in estimating synergy gains by reference to synergy losses arising from exogenously failed deals. We identify 161 exogenously withdrawn deals (e.g., deals withdrawn due to regulatory intervention, litigation, and competing offers) over our sample period. Whereas Wang (2018) estimates the average acquirer wealth effect by subtracting from the conventional three-day average abnormal price reaction, the average abnormal return over a window starting one day after deal announcement and ending one deal after the withdrawal date (ANN+1_WITHDRAWN+1), we are interested in wealth effect estimates at the individual acquirer level for use in our subsequent cross-sectional tests. Because exogenously withdrawn deals are scarce, it is impossible to satisfactorily match withdrawn and completed deals in our sample. As such, we calculate an adjusted three-day price reaction by subtracting from the three-day ACAR, the mean estimated synergy losses in withdrawn deals in the same Fama-French-12 industry, as follows.

$$\mathrm{WDADJ\_ACAR}_{\mathrm{jt+1}} = \mathrm{ACAR}_{\mathrm{jt+1}} - \mathrm{FF12\_Mean}(\mathrm{ANN} + 1\_\mathrm{WITHDRAWN} + 1). \tag{11}$$

Despite the coarseness of the adjustment, when we require five or more withdrawn deals in each Fama-French 12 industry to compute a mean ANN+1_WITHDRAWN+1 return over the whole sample period, we lose five of the 12 industry groups, which however only represent a minority of the deals in our sample.

Appendix 3 Variable Definitions

Merger Wealth Effects	
ACAR	The acquirer's three-day cumulative abnormal return around the deal announcement (−1, +1). The CAPM model is used to calculate expected returns. Benchmark model parameters are estimated using daily returns over the one-year period ending two months prior to deal announcement.
TCAR	The target's three-day cumulative abnormal return around the deal announcement (−1, +1). The CAPM model is used to calculate expected returns. Benchmark model parameters are estimated using daily returns over the one-year period ending two months prior to deal announcement.
SYN	The three-day cumulative abnormal return of a value-weighted portfolio of the acquirer and the target. Weights are based on the market capitalization of the acquirer and the target two months prior to deal announcement. The percentage of the target owned by the acquirer prior to the merger (i.e., toehold) is deducted from the target's weight.
ADJ_ACAR	The acquirer's three-day cumulative abnormal return around the deal announcement (−1, +1), adjusted for industry shocks, partial anticipation, and signals about the acquirer's standalone valuation, calculated following the procedure described in Section 3.3.1.
WDADJ_ACAR	The acquirer's three-day cumulative abnormal return around the deal announcement (−1,+1), adjusted for the industry-average withdrawn deal return, calculated over the period starting one day after deal announcement to one day after deal withdrawal, on a sample of 166 exogenously withdrawn deals, following the procedure described in Section 3.3.2.
ADJ_SYN	The three-day cumulative abnormal return of a value-weighted portfolio of the acquirer and the target, using ADJ_ACAR calculated following the procedure described in Section 3.3.1 as a proxy for the acquirer's return. Weights are based on the market capitalization of the acquirer and the target two months prior to deal announcement. The percentage of the target owned by the acquirer prior to the merger (i.e., toehold) is deducted from the target's weight.
WDADJ_SYN	The three-day cumulative abnormal return of a value-weighted portfolio of the acquirer and the target, using WDADJ_ACAR as described Section 3.3.2 as a proxy for the acquirer's return. Weights are based on the market capitalization of the acquirer and the target two months prior to deal announcement. The percentage of the target owned by the acquirer prior to the merger (i.e., toehold) is deducted from the target's weight.
PREMIUM	Premium is the initial offer price or the final offer price if the initial offer price is missing, divided by the target's stock price two months prior to deal announcement, minus one (i.e., [(offer price / pre-merger price) -1]. We set premium to missing if it is greater than two.
TGAIN	The relative gain to the target firm is the dollar gain of the target (i.e., target's market cap × TCAR) minus the dollar gain of the acquirer (acquirer's market cap × ACAR), divided by the sum of the acquirer's and target's market capitalization two months prior to deal announcement.
Acquired Intangible Asset Fair Values from Purchase Price Allocation	
GOODWILL	The fair value of goodwill divided by the deal value.
IPR&D	The fair value of in-process R&D divided by the deal value.
TECH	The fair value of technologies divided by the deal value.

RIGHTS	The fair value of legal rights divided by the deal value.
CLIENTS	The fair value of client relationships divided by the deal value.
TRADEMARK	The fair value of trademarks divided by the deal value.
INT_OTHER	The fair value of other intangible assets divided by the deal value.
TECH_PATENT	The fitted dollar value of patented technology based on the methodology described in Section 3.2 and divided by the deal value.
TECH_UNPATENT	The residual dollar value of unpatented technology based on the methodology described in Section 3.2 and divided by the deal value.
IPRD_PATENT	The fitted dollar value of patented in-process R&D based on the methodology described in Section 3.2 and divided by the deal value.
IPIPRD_UNPATENT	The residual dollar value of unpatented in-process R&D based on the methodology described in Section 3.2 and divided by the deal value.
Control Variables	
RELATIVESIZE	The deal value divided by the acquirer's market capitalization two months prior to deal announcement.
TENDER	An indicator variable that equals one for mergers bought by a tender offer (SDC).
DIVERSIFY	An indicator variable that equals one if the acquirer's and target's primary two-digit SIC codes differ (SDC).
$SIZE^{A}$	The natural logarithm of the acquirer's market capitalization (in thousands) two months prior to the deal announcement.
BTM^{A}	The acquirer's book-to-market ratio in the end of the fiscal year prior to the deal announcement. Book-to-market ratio is book value of equity divided by market value of equity (Compustat: [(SEQ / (PRCC_F × CSHO)]).
TAX^{A}	The amount of total net operating loss carryovers by the acquirer in the year prior to the deal (Compustat).
$RUNUP^{T}$	The target's abnormal buy-and-hold return measured over the one-year period ending two-months prior to deal announcement. Abnormal returns are individual firms' returns minus market return.
$CAPRD^{A}$	The acquirer's capitalized R&D at the end of the fiscal year prior to deal announcement, deflated by total assets. The capitalization schedule follows Lev and Sougiannis (1996). Missing R&D is set to zero.
$CAPADV^{A}$	The acquirer's capitalized advertising expenditures at the end of the fiscal year prior to deal announcement, deflated by total assets. The capitalization schedule follows Penman and Zhang (2002). Missing advertising expense is set to zero.
$INTAN^{A}$	The acquirer's recognized intangible assets on the balance sheet at the end of the fiscal year prior to deal announcement divided by total assets.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11142-021-09613-9.

Acknowledgements We thank Jan Bena for sharing technological proximity data, Pavel Savor for the data on withdrawn deals over the period 2000–2003, Noah Stoffman for access to patent data, and Craig Eich, Marshall Han, Congci Hao, Jiawei Li, Yulong Li, Yuqi Yang, and Yingyuan Zhang for their research assistance. We gratefully acknowledge the helpful comments and suggestions from an anonymous reviewer, Ciao-Wei Chen (discussant), Martin Glaum, Claudia Imperatore, Russell Lundholm (editor), Garen Markarian, Gabriel Pundrich, Charles Trzcinka, Wenyu Wang, workshop participants at Bocconi University, Florida International University, Indiana University, and the Otto Beisheim School of Management, and participants at the HARC, FARS, AAA and EAA conferences. Any errors are our own.

References

Ahern, K.R. (2012). Bargaining power and industry dependence in mergers. *Journal of Financial Economics* 103: 530–550.

Akcigit, U., M.A. Celik, and J. Greenwood. (2016). Buy, keep, or sell: Economic growth and the market for ideas. *Econometrica* 84: 943–984.

Aleszczyk, A., E. T. De George, A. Ertan, and F. P. Vasvari. (2019). Debt financing and collateral: The role of fair-value adjustments. Working paper, New York University, University of Miami, London Business School. **Available at** https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3032580.

Alimov, A., and M.S. Officer. (2017). Intellectual property rights and cross-border mergers and acquisitions. *Journal of Corporate Finance* 45: 360–377.

Andrade, G., M. Mitchell, and E. Stafford. (2001). New evidence and perspectives on mergers. *Journal of Economic Perspectives* 15: 103–120.

Anton, J.J., and D.A. Yao. (2004). Little patents and big secrets: Managing intellectual property. *RAND Journal of Economics* 35: 1–22.

Arnott, R., C.R. Harvey, V. Kalesnik, and J. Linnainmaa. (2021). Reports of value's death may be greatly exaggerated. *Financial Analysts Journal* 77 (1): 44–67.

Arora, A., W.M. Cohen, and J.P. Walsh. (2016). The acquisition and commercialization of invention in American manufacturing: Incidence and impact. *Research Policy* 45: 1113–1128.

Bauman, M.P., and K.W. Shaw. (2018). Value relevance of customer-related intangible assets. *Research in Accounting Regulation* 30: 95–102.

Bena, J., and K. Li. (2014). Corporate innovations and mergers and acquisitions. *Journal of Finance* 69: 1923–1960.

Beneish, M.D., I.P. Jansen, M.F. Lewis, and N.V. Stuart. (2008). Diversification to mitigate expropriation in the tobacco industry. *Journal of Financial Economics* 89: 136–157.

Betton, S., B. E. Eckbo, and K. S. Thorburn. (2008). Corporate takeovers. In *Handbook of corporate finance: Empirical corporate finance*, Vol. II. Chap. 15, pp.291–429. Ed. B.E. Eckbo. Amsterdam: Elsevier.

Bhattacharya, S., and J.R. Ritter. (1983). Innovation and communication: Signaling with partial disclosure. *Review of Economic Studies* 50: 331–346.

Bloom, N., C.I. Jones, J.V. Reenen, and M. Webb. (2020). Are ideas getting harder to find? *American Economic Review* 110: 1104–1144.

Bradley, M., A. Desai, and E.H. Kim. (1988). Synergistic gains from corporate acquisitions and their division between the stockholders of target and acquiring firms. *Journal of Financial Economics* 21: 3–40.

Bushee, B.J., T. Keutsch and J. Kim-Gina. (2020). Co-opetition and the firm's information environment. Working paper, Wharton School, University of Pennsylvania.

Cai, Y., and M. Sevilir. (2012). Board connections and M&a transactions. *Journal of Financial Economics* 103: 327–349.

Carr, C., and L. Gorman. (2001). The revictimization of companies by the stock market who report trade secret theft under the economic espionage act. *Business Lawyer* 57: 25–53.

Chan, L.K., J. Lakonishok, and T. Sougiannis. (2001). The stock market valuation of research and development expenditures. *Journal of Finance* 56: 2431–2456.

Cohen, W. M., R. R. Nelson, and J. P. Walsh. (2000). Protecting their intellectual assets: Appropriability conditions and why US manufacturing firms patent (or not). NBER Working paper. **Available at** http://www.nber.org/papers/w7552.

Corrado, C.A., and C.R. Hulten. (2010). How do you measure a "technological revolution"? *American Economic Review* 100: 99–104.

Cremers, M., V.B. Nair, and K. John. (2009). Takeovers and the cross-section of returns. *Review of Financial Studies* 22: 1409–1445.

Curtis, A., S. McVay, and S. Toynbee. (2020). The changing implications of research and development expenditures for future profitability. *Review of Accounting Studies* 25: 405–437.

Deng, Z., B. Lev, and F. Narin. (1999). Science and technology as predictors of stock performance. *Financial Analysts Journal* 55: 20–32.

Devos, E., P.R. Kadapakkam, and S. Krishnamurthy. (2009). How do mergers create value? A comparison of taxes, market power, and efficiency improvements as explanations for synergies. *Review of Financial Studies* 22: 1179–1211.

Eberhart, A.C., W.F. Maxwell, and A.R. Siddique. (2004). An examination of long-term abnormal stock returns and operating performance following R&D increases. *Journal of Finance* 59: 623–650.

Edmans, A., I. Goldstein, and W. Jiang. (2012). The real effects of financial markets: The impact of prices on takeovers. *Journal of Finance* 67: 933–971.

Eisfeldt, A. L., E. T. Kim, and D. Papanikolaou, (2020). Intangible value. NBER working paper no. 28056. **Available at** https://www.nber.org/papers/w28056

Farre-Mensa, J., D. Hegde, and A. Ljungqvist. (2016). The bright side of patents. NBER working paper no. 21959. **Available at** http://www.nber.org/papers/w21959.

Fuller, K., J. Netter, and M. Stegemoller. (2002). What do returns to acquiring firms tell us? Evidence from firms that make many acquisitions. *Journal of Finance* 57: 1763–1794.

Glaeser, S. (2018). The effects of proprietary information on corporate disclosure and transparency: Evidence from trade secrets. *Journal of Accounting and Economics* 66: 163–193.

Glaeser, S., J. Michels, and R. E. Verrecchia. (2020). Discretionary disclosure and manager horizon: Evidence from patenting. *Review of Accounting Studies* online publication.

Griliches, Z. (1981). Market value, R&D, and patents. *Economics Letters* 7: 183–187.

Gu, H. (2005). Innovation, future earnings, and market efficiency. *Journal of Accounting, Auditing and Finance* 20: 385–418.

Hall, B.H., A. Jaffe, and M. Trajtenberg. (2005). Market value and patent citations. *RAND Journal of Economics* 36: 16–38.

Hall, B.H., C. Helmers, M. Rogers, and V. Sena. (2014). The choice between formal and informal intellectual property: A review. *Journal of Economic Literature* 52: 375–423.

Healy, P.M., K.G. Palepu, and R.S. Ruback. (1992). Does corporate performance improve after mergers? *Journal of Financial Economics* 31: 135–175.

Higgins, M.J., and D. Rodriguez. (2006). The outsourcing of R&D through acquisitions in the pharmaceutical industry. *Journal of Financial Economics* 80: 351–383.

Hirshleifer, D., P.-H. Hsu, and D. Li. (2013). Innovative efficiency and stock returns. *Journal of Financial Economics* 107: 632–654.

Hoberg, G., and G. Phillips. (2010). Product market synergies and competition in mergers and acquisitions: A text-based analysis. *Review of Financial Studies* 23: 3773–3811.

Horstmann, I., G.M. MacDonald, and A. Slivinski. (1985). Patents as information transfer mechanisms: To patent or (maybe) not to patent. *Journal of Political Economy* 93: 837–858.

Hsu, P.-H. (2009). Technological innovations and aggregate risk premiums. *Journal of Financial Economics* 94: 264–279.

Hsu, P.-H., D. Li, Q. Li, S. H. Teoh, and K. Tseng. (2020). Valuation of new trademarks. *Management Science*, forthcoming.

Hsu, P.-H., K. Li, X. Liu, and H. Wu. (2018). Consolidating product lines via mergers and acquisitions: Evidence from the USPTO trademark data. Working paper, National Tsing Hua University, University of British Columbia, and Fudan University. **Available at** https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3002520

Jankowski, J. E. (2012). Business use of intellectual property protection documented in NSF survey. NSF paper series 12-307.

Jensen, M.C., and R.S. Ruback. (1983). The market for corporate control: The scientific evidence. *Journal of Financial Economics* 11: 5–50.

Joos, P., and G.A. Plesko. (2005). Valuing loss firms. *The Accounting Review* 80: 847–870.

Kaplan, S.M., ed. (2000). *Mergers and productivity*. University of Chicago Press.

Kimbrough, M.D. (2007). The influences of financial statement recognition and analyst coverage on the market's valuation of R&D capital. *The Accounting Review* 82: 1195–1225.

Kimbrough, M.D., and H. Louis. (2011). Voluntary disclosure to influence investor reactions to merger announcements: An examination of conference calls. *The Accounting Review* 86: 637–667.

King, Z., T. Linsmeier, and D. Wangerin. (2019). Differences in the value relevance of identifiable intangible assets acquired in business combinations. Working paper, University of Wisconsin. **Available at** https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3438250.

Kogan, L., D. Papanikolaou, A. Seru, and N. Stoffman. (2017). Technological innovation, resource allocation, and growth. *The Quarterly Journal of Economics* 132 (2): 665–712.

Koh, D., R. Santaeulàlia-Llopis, and Y. Zheng. (2020). Labor share decline and intellectual property products capital. *Econometrica*, forthcoming.

Lanjouw, J.O., and M. Schankerman. (2004). Patent quality and research productivity: Measuring innovation with multiple indicators. *Economic Journal* 114: 441–465.

Lerner, J. (2006). Using litigation to understand trade secrets: A preliminary exploration. **Available at** https://papers.ssrn.com/sol3/papers.cfm?abstract_id=922520.

Lev, B., and T. Sougiannis. (1996). The capitalization, amortization, and value-relevance of R&D. *Journal of Accounting and Economics* 21: 107–138.
Levin, R., A. Kievorick, R. R. Nelson, and S. G. Winter. (1987). Appropriating the returns from industrial R&D. *Brookings Papers on Economic Activity*: 783–820.
Li, F. (2020). Intangibles: The missing ingredient in book value. *Journal of Portfolio Management,* forthcoming.
Li, X. (2013). Productivity, restructuring, and the gains from takeovers. *Journal of Financial Economics* 109: 250–271.
Lynch, D., M. Romney, B. Stomberg, and D. Wangerin. (2019). Trade-offs between tax and financial reporting benefits: Evidence from purchase price allocations in taxable acquisitions. *Contemporary Accounting Research* 36: 1223–1262.
Maksimovic, V., and G. Phillips. (2001). The market for corporate assets: Who engages in mergers and asset sales and are there efficiency gains? *Journal of Finance* 56: 2019–2065.
Maksimovic, V., G. Phillips, and N.R. Prabhala. (2011). Post-merger restructuring and the boundaries of the firm. *Journal of Financial Economics* 102: 317–343.
McCardle, K.F., and S. Viswanathan. (1994). The direct entry versus takeover decision and stock price performance around takeovers. *Journal of Business* 67: 1–43.
McGrattan, E.R., and E.C. Prescott. (2014). A reassessment of real business cycle theory. *American Economic Review* 104: 177–182.
McInnis, J. M., and B. Monsen. (2019). The operating returns to acquired intangible assets. Working paper, University of Texas at Austin and Ohio State University. **Available at** https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3279123.
Moeller, S.B., F.P. Schlingemann, and R.M. Stulz. (2004). Firm size and the gains from acquisitions. *Journal of Financial Economics* 73: 201–228.
Pandit, S., C.E. Wasley, and T. Zach. (2011). The effect of research and development (R&D) inputs and outputs on the relation between the uncertainty of future operating performance and R&D expenditures. *Journal of Accounting, Auditing and Finance* 26: 121–144.
Park, Hyuna. (2020). "An Intangible-adjusted Book-to-market Ratio Still Predicts Stock Returns." Critical Finance Review (forthcoming).
Paugam, L., P. Astolfi, and O. Ramond. (2015). Accounting for business combinations: Do purchase price allocations matter? *Journal of Accounting and Public Policy* 34: 362–391.
Penman, S.H., and X.J. Zhang. (2002). Accounting conservatism, the quality of earnings, and stock returns. *The Accounting Review* 77: 237–264.
Phillips, G., and A. Zhdanov. (2013). R&D and the incentives from merger and acquisition activity. *The Review of Financial Studies* 26: 34–78.
Png, I.P.L. (2017). Law and innovation: Evidence from state trade secrets laws. *Review of Economics and Statistics* 99: 167–179.
Potepa, J., and K. Welch. (2018). Calibrating innovation proxies with an accurate Tobin's Q and appraised innovation value. Working paper, George Washington University. **Available at** https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2990481.
Ravenscraft, D.J., and F.M. Scherer. (1987). *Mergers, sell-offs, & economic efficiency*. The Brookings Institution.
Rhodes-Kropf, M., and D.T. Robinson. (2008). The market for mergers and the boundaries of the firm. *Journal of Finance* 63: 1170–1211.
Rowe, E.L. (2009). Contributory negligence, technology, and trade secrets. *George Mason Law Review* 17: 1–37.
Savor, P., and Q. Lu. (2009). Do stock mergers create value for acquirers? *The Journal of Finance* 64: 1061–1097.
Scherer, F.M. (1965). Firm size, market structure, opportunity, and the output of patented inventions. *American Economic Review* 55: 1097–1125.
Schipper, K., and R. Thompson. (1983). Evidence on the capitalized value of merger activity for acquiring firms. *Journal of Financial Economics* 11: 85–119.
Schoar, A. (2002). Effects of corporate diversification on productivity. *Journal of Finance* 57: 2379–2403.
Seru, A. (2014). Firm boundaries matter: Evidence from conglomerates and R&D activity. *Journal of Financial Economics* 111: 381–405.
Sevilir, M., and X. Tian. (2012). Acquiring innovation. Working paper, Indiana University. **Available at** https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1731722.
Shalev, R. (2009). The information content of business combination disclosure level. *The Accounting Review* 84: 239–270.

Shalev, R., I. Zhang, and Y. Zhang. (2013). CEO compensation and fair value accounting: Evidence from purchase price allocation. *Journal of Accounting Research* 51: 819–854.

Sheen, A. (2014). The real product market impact of mergers. *Journal of Finance* 69: 2651–2688.

Shleifer, A., and R.W. Vishny. (1992). Liquidation values and debt capacity: A market equilibrium approach. *Journal of Finance* 45: 379–396.

Song, M., and R. Walkling. (2000). Abnormal returns to rivals of acquisition targets: A test of the 'acquisition probability hypothesis. *Journal of Financial Economics* 55: 143–171.

Teece, D.J. (1980). Economies of scope and the scope of the enterprise. *Journal of Economic Behavior and Organization* 1: 223–247.

Trajtenberg, M. (1990). A penny for your quotes: Patent citations and the value of innovations. *RAND Journal of Economics* 21: 172–187.

Travlos, N.G. (1987). Corporate takeover bids, method of payment, and bidding firms' stock returns. *Journal of Finance* 42: 943–963.

Wang, W. (2018). Bid anticipation, information revelation, and merger gains. *Journal of Financial Economics* 128: 320–343.

Zhang, I., and Y. Zhang. (2017). Accounting discretion and purchase Price allocation after acquisitions. *Journal of Accounting* 32: 241–270.