INTANGIBLE ASSETS AND CAPITAL STRUCTURE

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Abstract

While intangible assets represent substantial proportions of corporate assets, they are largely absent from balance sheets. Consequently, the empirical capital structure research has struggled to quantify the effects of intangible assets on leverage. High valuation risk and poor collateralizability can discourage debt financing, but some intangible assets are separately identifiable, valuable, and collateralizable, and may therefore support debt. Utilizing a recent accounting rule change that allows us to observe granular market-based valuations of intangible assets, we find a strong positive relation between intangible assets and financial leverage. Overall, intangible assets support debt financing as much as tangible assets do.

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"The big difference between the new economy and the old is the changed nature of investment. In the past, businesses primarily invested in the tangible means of production, things like buildings and machines. The value of a company was at least somewhat related to the value of its physical capital; to grow bigger, a business had to build new factories roughly in proportion to the increase in its sales. But now businesses increasingly invest in intangibles. And once you've designed a chip, or written the code for a new operating system, no further investment is needed to ship the product to yet another customer." (Paul Krugman, *New York Times*, 22 October 2000)

"Brands are the most valuable assets many companies possess. But no one agrees on how much they are worth or why." (*The Economist*, 30 August 2014)

1. Introduction

It has long been recognized that intangible assets can be critically important to firm value and potentially affect firms' financial policies. For example, the patents of Apple and Pfizer, the brands of Coke and Amazon, the unique supply chain of Walmart, and the highly efficient business process of Southwest Airlines have bolstered the competitive advantages and corporate values of these firms in the knowledge economy (Lev and Gu 2016). However, heretofore it has been difficult to assess their importance since their values are largely unobservable. For example, firms' research and development (R&D) expenditures are expensed and usually do not find their way onto the firms' balance sheets. This study focuses on the relation between intangible assets and financial leverage. Our primary objective is to document the extent to which intangible assets support debt. Are intangible assets, due to characteristics such as high valuation risk and poor collateralizability, unable to support debt? Or do they support debt like tangible assets do? We answer these questions with a novel dataset that offers comprehensive accounts of the fair values of firms' intangible assets.

The capital structure research has struggled to empirically quantify the effects of intangible assets on leverage. The problem lies in accounting rules that distinguish between two types of intangible assets: those that firms acquire externally, through transactions such as mergers and acquisitions or purchases of patents or brands, and those that firms generate internally.

Accountants do not reflect the internally-generated intangible assets, essentially all intangible assets that the firm did not acquire externally, in financial statements, due to the conservatism tradition in accounting and the difficulty, cost, and effort associated with valuing intangible assets.[1] Instead, accounting rules require firms to expense the costs associated with creating these intangible assets. As the quote from The Economist (2014a) above implies, the internally-generated intangible assets frequently include items of substantial value, such as brand names, trademarks, patents, developed technology, in-process research and development, and customer relationships. Peters and Taylor (2017) estimate that, on average, only 19% of firms' intangible assets are purchased externally. The Economist (2014b) reports that "[i]n 2005 Procter & Gamble, a consumer-goods company, paid $57 billion for the Gillette razor company. The brand alone, P&G reckoned, was worth $24 billion." For these intangible assets, researchers usually cannot even observe book values, not to mention market or fair values. The only exception are sporadic estimates like the ones The Economist (2014a, 2014b) refers to.

Our study circumvents this data problem by taking advantage of a recent accounting rule change that allows us to observe granular fair values of internally-generated intangible assets of all U.S. public targets that were acquired by U.S. public acquirers between 2002 and 2014. For mergers and acquisitions since 2001, acquirers must allocate the purchase prices they pay for targets to the tangible and identifiable intangible assets they acquire, and the remainder to

[1] According to the Wall Street Journal (2016), "the FASB [Financial Accounting Standards Board] hasn't been able to find a solution in which benefits of reporting intangibles outweigh the costs." Internally-generated intangibles are treated as regular expenses, whereas the same intangibles, if acquired, are considered assets and are capitalized. Under standard accounting definitions, assets provide future benefits while expenses are payments without future benefits. Thus, the mandatory expensing on internally-generated intangible assets is extremely conservative in that it implies no reliable future benefits. Hirshleifer, Hsu, and Li (2013) provide contradictory evidence to this implication of accounting rules by showing that a higher innovation efficiency measure, i.e., patents per dollar R&D, predicts significantly higher returns on assets, cash flows, and future stock returns.

goodwill.[2] Acquirers must report these purchase price allocations in U.S Securities and Exchange Commission (SEC) filings that provide us with fair value estimates of the targets' tangible and identifiable intangible assets, including those intangible assets that the targets generate internally. We take these estimates of targets' tangible and intangible assets and test how they relate to the targets' pre-acquisition financial leverage.[3] Since our sample is not randomly selected, we emphasize the descriptive nature of our results. Stretching to establish indubitable causality seems futile and relatively unimportant here because the results are new and intuitive, and we see no obvious endogeneity issues that could meaningfully distort our results.

Note that our measures of tangible and intangible assets differ primarily along two dimensions from the prior capital structure research, where tangibility is commonly defined as property, plant, and equipment scaled by total assets. We use fair value estimates instead of book values, and we separate intangible assets into identifiable intangible assets and goodwill. Prior studies usually find a positive relation between tangibility and leverage, implying a negative relation between intangible assets (scaled by total assets) and leverage if everything other than property, plant, or equipment is considered an intangible asset. Because we independently observe tangible assets and identifiable intangible assets, our analysis has no such mechanical constraint. Goodwill, i.e., the residual purchase price after subtracting tangible and identifiable intangible

[2] For ease of exposition, we refer to "identifiable intangible assets" simply as "intangible assets" when the meaning is clear in the context. An intangible asset is identifiable if it arises from contractual or other legal rights (the contractual or legal criterion) or is separable from the business (the separability criterion). For example, if a firm leases a manufacturing facility under terms that are favorable relative to market terms, then the amount by which the lease terms are favorable compared to current market rates is an intangible asset that meets the contractual or legal criterion for recognition separately from goodwill. An intangible asset meets the separability criterion if there is evidence of exchange transactions, even infrequent ones, for that type of asset. For example, the fact that customer lists are frequently licensed means that they meet the separability criterion, even if a specific customer list has unique characteristics.

[3] Harford, Klasa, and Walcott (2009) also examine financial leverage in a mergers and acquisitions setting.

assets, is the third component of firm value in our study that adds the degree of freedom that avoids forcing the coefficients on tangible assets and identifiable intangible assets to have opposite signs.

While it has been challenging to assess the relation between intangible assets and leverage, the literature has established that firms with more tangible assets tend to have more debt. There are several possible explanations for this phenomenon, among them that many tangible assets constitute suitable collateral (Harris and Raviv 1991; Frank and Goyal 2008; Parsons and Titman 2009) because they can be redeployed at relatively low transaction costs when the borrower defaults or becomes distressed. Tangible assets also tend to be less risky and easier to value than intangible assets. Therefore, borrowing costs should be relatively low when tangible assets support firms' debt, resulting in a positive relation between asset tangibility and financial leverage.[4]

As in the prior literature, firms with higher tangibility have on, average, higher financial leverage in our sample. Our new and interesting finding is that firms' use of financial leverage is also positively related to identifiable intangible assets and that this relation is both statistically significant and economically large. Therefore, our finding is an extension of, not a replacement for, the established leverage-tangibility results.

Our primary contribution to the literature is that we can quantify the effect of intangible assets on debt levels. Quantifying this effect has been largely impossible in the existing research that primarily analyzes imprecise proxies for intangible assets, for example patents with indeterminable values, instead of fair values of intangible assets. We show that the quantitative impact of intangible assets is substantial as the coefficient estimates of intangible assets are similar to those of tangible assets in our leverage regressions.

[4] Campello and Giambona (2013) analyze the effects of different components of tangible assets on leverage. They show that it is not only the tangibility of assets that increases the use of leverage, but also the ease with which tangible assets can be sold.

The results suggest that identifiable intangible assets can support debt well because they function similarly to collateralizable tangible assets. While they may be more difficult to use as collateral than many tangible assets, the fact that they are identifiable and separately valuable implies that they should have substantial value in the hands of a different owner. This preservation of the value of identifiable intangible assets when transferred to new owners stands in stark contrast to the potentially substantial value destruction in transfers of unidentifiable intangible assets, e.g., goodwill.

Our insights are vital because intangible assets play an increasingly important role in today's knowledge-based economy and make traditional accounting measures less relevant. Nakamura (2001, 2003) estimates that a third of the value of U.S. corporate assets are intangible assets. The annual investment rate in intangible assets in the U.S. is $1 trillion as of 2001, practically equal to that in tangible assets according to Nakamura's analysis. In 2014, the investment rate in intangible assets represented 14% of private sector gross domestic product compared to 10% in tangible assets according to the Wall Street Journal (2016). Lev and Gu (2016) show that the rate of investment in tangible assets fell by 35% while the rate of investment in intangible assets increased by 60% between 1977 and 2014. By 2014, the intangible and tangible investment rates, relative to gross value added, were 14% and 10%, respectively, virtually mirror images of what they were in 1977. Furthermore, the larger role of intangibles has led to a decrease in accounting relevance, measured by the r-squareds of regressions that explain market capitalizations with annual earnings and book values, from over 80% in the 1950s to about 25% in the 2000s.

We also find an association between firms' types of debt and the relative prevalence of tangible and intangible assets. Firms with relatively few tangible assets are likely riskier borrowers.

Correspondingly, these firms tend to have debt with features that better protect the lenders from risk, such as relatively shorter maturities, more term loans, more bank debt, more convertible debt, less unsecured debt, and less fixed-rate debt.[5]

Overall, our results show that identifiable intangible assets behave in many respects like tangible assets in their effects on capital structure. Therefore, the focus of the existing empirical capital structure literature on tangibility, necessitated by data availability, can lead to misspecified, incomplete, and potentially misleading estimations. As a case in point, one result in Rauh and Sufi (2010) is that tangibility does not help explain the fraction of bank debt in total book capital. This finding is not surprising because, as we show, bank debt is particularly prevalent in firms where intangible assets constitute relatively high proportions of firm value, and the usual measures of tangibility do not reflect differing amounts of intangible assets.

The relation between intangible assets and leverage has long been recognized theoretically, for example in Shleifer and Vishny (1992) and Morellec (2001), but has been difficult to examine empirically. Titman and Wessels (1988) use the ratio of intangibles to total assets as a proxy for the collateralizability of a firm's assets and find a negative relation between this ratio and leverage. However, likely because they are not reported in financial statements, their measure of intangibles does not include internally-generated intangible assets that arose, for example, out of the firm's own R&D or brand management efforts, but does include goodwill which is difficult to interpret. Mann (2015) uses patents as a proxy for intangible assets and finds that court decisions that enhance creditor rights in default increase the role of patents as collateral and allow patenting companies to raise more debt. Hochberg, Serrano, and Ziedonis (2017) find surprisingly extensive venture lending, backed by patent assets with liquid secondary markets, in startups. Patents may

[5] Denis and Mihov (2003) show that the borrower's credit quality affects the type of debt.

serve as a decent proxy for intangible assets, but our intangible asset measure is much more inclusive and provides a more direct reflection of the market value of a firm's intangible assets. It is also the only measure that allows us to quantify the relation between the market value of intangible assets and debt. Peters and Taylor (2017) account for intangible assets in examining the relation between investment and Tobin's q. They broadly estimate intangible assets as knowledge and organizational capital from past R&D spending and selling, general, and administrative expenses. While they can calculate their estimates for most Compustat firms, these estimates are an indirect measure of intangible assets. For example, their measures do not differ whether the past expenses had successful outcomes, i.e., resulted in valuable assets, or not. Furthermore, they cannot distinguish between identifiable and unidentifiable intangible assets, a distinction that seems to be critical for the collateralizability of the intangible assets.[6]

2. Purchase price allocation and Statement of Financial Accounting Standards 141

Prior studies do not use intangible assets as determinants of leverage because the values of firms' internally-generated intangible assets are largely unobservable. We get around this data limitation with a unique dataset that takes advantage of a recent accounting rule change that requires an acquiring firm to provide granular fair value estimates of the target firm's identifiable intangible assets. Starting in July 2001, Statement of Financial Accounting Standards (SFAS) 141 requires that an acquiring firm allocates the purchase price paid for a target to identifiable assets, both tangible and intangible, based on estimated fair values at the time of the acquisition, before allocating the remaining purchase price to goodwill.[7] Acquirers report these estimates of the fair

[6] Clausen and Hirth (2016) proxy for intangible asset intensity with a ranking by return on tangible assets and find a negative correlation between intangible asset intensity and leverage. Their intangible asset measure also includes unidentifiable intangible assets, like goodwill, in contrast to our focus on identifiable intangible assets.

[7] Financial Accounting Standards Board (FASB) standards are now incorporated into FASB's Accounting Standards Codification (ASC), and SFAS 141 can be found under FASB ASC 805: Business Combinations. However, to be consistent with prior literature, we will refer to SFAS 141 instead of ASC 805. FASB revised SFAS 141 in 2007 and

values of the tangible and intangible assets in 10-Ks or 10-Qs where we obtain them with the generous help of Houlihan Lokey.[8] In effect, SFAS 141 provides the fair values of target firms' identifiable intangible assets that are based on arm's length transactions. Prior to SFAS 141, acquirers allocated most of the intangible portion of the purchase price to acquisition goodwill without providing detailed valuations of identifiable intangible assets.[9] For example, Henning, Lewis, and Shaw (2000) report that acquirers allocate, on average, 57% of the purchase price to acquisition goodwill prior to SFAS 141 while it is only 38% in our post-SFAS 141 data. Like other recent papers, our study validates the relevance of the SFAS 141-based purchase price allocation data.[10]

We also examine the effects of components of intangible assets on leverage. Under SFAS 141, acquirers allocate the purchase price to two main categories, tangible and intangible assets. The intangible assets category comprises three categories of identifiable intangible assets and one category of unidentifiable intangible assets, i.e., acquisition goodwill. Among the identifiable

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it is now called SFAS 141R. Paragraph 14 of SFAS 141R states that "The acquirer's application of the recognition principle and conditions may result in recognizing some assets and liabilities that the acquiree [target] had not previously recognized as assets and liabilities in its financial statements. For example, the acquirer recognizes the acquired identifiable intangible assets, such as a brand name, a patent, or a customer relationship, that the acquiree [target] did not recognize as assets in its financial statements because it developed them internally and charged the related costs to expense."

[8] Houlihan Lokey is a publicly-traded investment banking firm founded in 1972. The firm operates through three main service lines: corporate finance (comprising mergers and acquisitions, capital markets, and second advisory), financial restructuring, and financial advisory services. For 2012, Houlihan Lokey ranked No. 1 in announced U.S. mergers and acquisitions deal volume for deals under $3 billion.

[9] Prior to SFAS 141, the accounting for mergers and acquisitions followed Accounting Principles Board (APB) Opinion 16, Business Combinations. Two methods of accounting, "purchase" and "pooling of interests," were allowed under APB 16. The "pooling" method combined assets and liabilities at book value. No fair values needed to be determined and no goodwill was created. The "purchase" method valued assets and liabilities at fair value and recognized intangible assets, including goodwill. In addition to eliminating the "pooling" method, SFAS 141 clarifies how intangibles should be valued in allocating the purchase price and requires reporting details on each major intangible asset class.

[10] For example, Kimbrough (2007) examines the relation between a target's market value before the acquisition and the fair value of its R&D subsequently reported in the acquirer's purchase price allocation. Shalev, Zhang, and Zhang (2013) document that CEOs whose compensation packages rely on earnings-based bonuses are more likely to overallocate the purchase price to goodwill because it helps boosting future reported earnings thanks to the removal of mandatory amortization of goodwill under SFAS 141.

intangible asset categories, technology-related intangible assets cover developed technologies, including patents, and in-process research and development. Marketing-related intangible assets consist of trademarks and trade names, including domain names, and customer-related assets, including backlog, customer contracts, and customer relationships. The third category contains all other identifiable intangible assets. Some examples of "other" intangible assets are unproved oil and gas properties, mineral rights, coal supply agreements, non-compete agreements, and leasehold interests.

3. Hypotheses

We develop our hypotheses in the context of the following leverage regression model:

$$Lev_i = \alpha + \beta Tan_i + \omega Int_i + \gamma Con_i + \varepsilon_i \quad (1)$$

where *Lev* is the long-term debt divided by total assets, *Tan* stands for the hand-collected fair value of the target's tangible assets reported in the purchase price allocation data of the acquiring firms' 10-Ks or 10-Qs, normalized by the purchase price, *Int* is identically constructed using the fair value of intangible assets, *Con* is a vector of control variables, and *i* denotes a firm. Since the fair value of identifiable intangible assets is available only upon the acquisition of the target, the purchase price allocation data limits us to a cross-sectional analysis. We omit goodwill from the regressions because *Tan* plus *Int* plus goodwill divided by the purchase price add up to one, i.e., we can only have two of the three variables in a regression at the same time.

We find it implausible that intangible assets have a negative effect on leverage because any valuable asset should contribute at least somewhat to a firm's debt capacity.[11] Still, this positive effect can be small or even insignificant, i.e., ω can be relatively small and may be even

[11] Empirically, it is possible to observe a negative relation between intangible assets and leverage if intangible assets proxy for other firm characteristics that are associated with low leverage, and we do not adequately control for such characteristics.

indistinguishable from zero. Intangible assets can be unrelated to leverage for at least three reasons. First, collateralizing intangible assets is challenging. Intangible assets tend to be more difficult to identify, separate, utilize, and value. Furthermore, repossessing intangibles in case of default or bankruptcy is difficult, and agency problems can prevent the efficient use of intangible assets in production processes by anyone other than the owners of the intangible assets (Rampini and Viswanathan 2013). Second, and partially related to the first point, intangible assets traditionally have been regarded as more risky than tangible assets. Financing risky assets with equity should be more appropriate than financing them with debt in most cases. Third, intangible assets can be unimportant when firms have sufficient tangible assets to support their desired leverage.

It is also possible that intangible assets provide important and substantial backing for leverage, in particular in light of intangible assets comprising increasing proportions of many firms' values. Loumioti (2012) reports that some intangible assets can constitute collateral. Some lenders accept liquid and redeployable intangible assets as collateral because they have found innovative ways of leveraging, financing, and valuing intangible assets. Ellis and Jarboe (2010) provide examples of such intangible asset-backed loans. Moreover, if the recent breed of intangible assets is less risky than traditional intangible assets, risk considerations may not prevent financing intangible assets with debt. Supporting this view, Larkin (2013) argues that positive consumer attitude towards a brand, an intangible asset, reduces the overall firm riskiness. She finds that firms use the higher stability provided by better brand perception to increase leverage and lower cash holdings. For these reasons, many intangible assets can support debt, i.e., ω can be significantly positive and relatively large.

We have several mechanisms in mind when we claim that, in particular collateralizable, assets support debt. Collateral should reduce borrowing costs (see Figure 1), and lower borrowing

costs should lead to more debt financing. Collateralized debt is less information-sensitive than regular debt and, in the spirit of Myers and Majluf (1984), reduces the effects of asymmetric information. It can also prevent asset substitution that would otherwise lead to higher borrowing costs. For example, the more value that lenders can recover in case of the borrower's bankruptcy, the less likely that the borrower substitutes low-risk with high-risk projects, which in turn allows the lenders to charge lower interest rates. Appendix A provides a simple numerical example of asset substitution. Other explanations can rely on moral hazard based on the *inalienability of human capital* as in Hart and Moore (1994) or private benefits as in Holmstrom and Tirole (1997).

Another possibility is that intangible assets reliably generate cash flows that can support debt, just like personal labor income can back personal loans. An example is a brand name that allows a firm to sell its products at higher profit margins. Assets that reliably generate cash flows, even if these assets are not collateralizable, should lead to lower interest rates and, all else equal, more debt.

4. Data

Our sample comprises all non-financial U.S. public firms that became targets of completed acquisitions by U.S. public acquirers between 2002 and 2014 and have sufficient purchase price allocation (PPA) data. Houlihan Lokey provides us the original dataset of 6,133 acquisitions with PPA information that is hand-collected from 10-Ks and 10-Qs. We match the 6,133 targets with Compustat using target company names. This matching reduces the sample to 1,216 targets. Limited data availability in Compustat and the exclusion of subsidiary and foreign targets further

reduce the sample size to 609 firms.[12] After excluding financial firms, our final sample consists of 469 firms.

The unique feature of our dataset is that it provides fair values of tangible and intangible assets based on arms' length transactions between targets and acquirers. With these exceptional data, we examine the relation between a target's tangible and intangible assets at the time of the acquisition and the target's leverage at the last fiscal year-end before the acquisition.

The dataset has three drawbacks. First, it is limited to target firms that are successfully acquired by other firms. Firms that become targets and are eventually acquired may have unique unobservable characteristics that drive a positive correlation between intangibles and leverage. Controlling for such biases and the endogeneity of becoming a target is difficult because we lack appropriate instruments. Yet, other evidence indicates that our findings likely apply beyond our sample. For example, our sample firms are similar along many dimensions to the Compustat universe of firms. Second, our sample provides a snapshot of the fair market values of targets' assets at the time of their acquisitions. Therefore, our analyses are limited to being strictly cross-sectional. Third, we have to assume that there are no systematic changes in the values of these assets in the year immediately prior to the acquisitions. While asset values generally change over the year before an acquisition, and such value changes can even be the reasons for some acquisitions, if the changes are not systematic, they should primarily add noise to our estimations.

[12] We exclude from our sample 50 observations where the total purchase price allocation is less than half of the target's book or market value of assets at the time of the last fiscal year-end of the target because a negative 50% offer premium suggests a severely distressed target. For such targets, our assumption of no substantial change in the target's business situation between the prior fiscal year-end and the acquisition date is almost certainly violated. Furthermore, the negative 50% threshold can capture subsidiary or similar deals that we potentially failed to remove from the sample. Our results are qualitatively similar if we include these 50 observations.

Ultimately, there currently exists no other good alternatives to our sample for accurately measuring the fair value of firms' internally-generated intangible assets.[13]

Figure 2 shows the composition of purchase price allocations. It is a modified copy from the Houlihan and Lokey 2011 Purchase Price Allocation Study. Appendix B shows how the disclosure formats of the purchase price allocations in their 10-K filings to the SEC differ between two firms in our final sample. These variations in the reporting formats make collecting the purchase price allocation data nontrivial. The first example in Appendix B is the case of Zhone Technologies acquiring Sorrento Networks in July 2004. Zhone Technologies allocates the total purchase price of $98 million to net tangible assets of $23.4 million, amortizable intangible assets of $14.8 million (consisting of $9.2 million of core technology and $5.6 million of customer relationships), in-process R&D of $2.4 million, and acquisition goodwill of $57.2 million. The second example in Appendix B is K2 Inc.'s acquisition of Brass Eagle, Inc. in December 2003. K2 allocates the purchase price of $81.7 million to $16.4 million of net tangible assets and $65.3 million of intangible assets. The intangible assets consist of $27 million of identifiable intangible assets ($1.9 million of patents, $0.2 million of order backlog, $0.3 million of trademarks, and $24.6 million of trade names and trademarks with indefinite lives not subject to amortization), and $38.4 million of acquisition goodwill.

We first compare our sample to the Compustat universe. The first two columns of Table 1 show the variable means and medians of these 96,239 firm-year observations of non-financial Compustat firms during our sample period. The remaining columns present the descriptive

[13] A possible estimate would be the difference between the market value of the firm and the book value of assets. Yet, it is unclear whether such an estimate measures the value of intangible assets, the difference between the market and book values of tangible assets, or the firm's future growth potential. Furthermore, this variable is mechanically tied to market leverage and therefore not useful in examining market leverage. It also cannot distinguish between identifiable and unidentifiable intangible assets.

statistics for our 469 sample firms. Appendix C defines all variables. Unless otherwise noted, all variables are measured at the last fiscal year-end before the acquisition announcement. We winsorize all variables, except for *Marginal tax rate*, at 1% and 99% to reduce the impact of extreme observations.[14]

Compared to the Compustat universe, the firms in our sample tend to be smaller, have higher market-to-book ratios, have fewer tangible assets, have higher cash liquidity, have less debt, and face lower marginal tax rates. Overall, these characteristics are consistent with younger firms that tend to be typical acquisition targets. Most of these differences are statistically significant, but have only small to moderate magnitudes. In terms of leverage, average book and market leverage are lower for our sample firms compared to the Compustat universe. There is little change in leverage over the three years before the acquisitions.

Table 2 shows the purchase price allocation data. Panel A presents the purchase price allocation in dollar amounts and Panel B in percentages of the total purchase price. All purchase price allocation data are hand-collected from acquirers' 10-Ks or 10-Qs. *Purchase price* (abbreviated *PP*) is the sum of *Tangible assets*, *Intangible assets*, and *Goodwill* from the PPA dataset. The main variable of interest in our subsequent analysis is *Intangible assets/ PP* while we control for *Tangible assets/ PP*. On average, 36% of the purchase price is allocated to tangible assets, 25% to identifiable intangible assets, and the remaining 38% to acquisition goodwill. The 25% allocated to identifiable intangible assets consist of 11% technology-related, 11% marketing-related, and 3% other intangible assets. Customer-related intangible assets are the main component of marketing-related intangibles. Developed technology is the main component of technology-related intangible assets.

[14] The means of *Operating profitability* are substantially negative due to surprisingly common large negative outliers caused by observations with very small *Assets*, the denominator of *Operating profitability*.

Panel A of Table 3 presents the distribution of our PPA sample and the Compustat universe across the 12 Fama-French industries. We find higher proportions of acquisitions in certain industries, consistent with acquisitions occurring in industry waves (e.g., Mitchell and Mulherin 1996; Maksimovic and Phillips 2001; Rhodes-Kropf, Robinson, and Viswanathan 2005; Harford 2005; Ahern and Harford 2014). The industry variation of the purchase price allocation components in Panel B of Table 3 are largely as expected. For example, the top four industries with the highest intangible assets are healthcare, consumer non-durables, telecommunications, and business equipment. Healthcare has the highest percentage of technology-related intangible assets followed by the business equipment industry. Consumer non-durables has the highest percentage of marketing-related intangible assets.[15] Not surprisingly, utilities have the least intangible assets. Panel C shows that the consumer non-durables industry's marketing-related intangible assets consist primarily of tradenames and brands while healthcare's technology-related intangible assets are about equally split between developed technology and in-process R&D.

5. Multivariate analysis of the relation between intangible assets and leverage

We design our multivariate tests to examine the extent of the relation between intangible assets and leverage, controlling for the variables already established in the literature, in particular tangible assets.

5.1. Analysis of aggregate intangible assets

Because our dependent variable is truncated at zero with 26% of firms in our sample having no leverage, Tobit estimations would be appropriate.[16] Since the Tobit results are similar to those

[15] Because most sample firms in the telecommunication industry are small and engaged in broadcasting and integrated telecommunication services, their intangible assets tend to be marketing-related rather than technology–related.

[16] Similarly, Strebulaev and Yang (2013) report that 22% of their sample firms have leverage ratios below 5%.

from using ordinary least squares (OLS) with and without deleting the observations with zero leverage, and for ease in interpreting the results, we present the OLS estimations (without deleting the observations with zero leverage) in the paper. We assess statistical significance with heteroskedasticity-robust standard errors clustered by industry using the Fama-French 12-industry classification.[17]

Leverage, i.e., book leverage, is the dependent variable in columns 1 through 3 of Table 4 while it is *Market leverage* in columns 4 through 6. We control for common determinants of leverage that have been used in the literature.[18] *Log Market capitalization* and *Log Sales* control for firm size as larger firms tend to be more leveraged. Since fast growing firms may have less debt, *Market-to-book* controls, among other, for growth opportunities. Profitability (*Operating profitability*) can have positive and negative effects on leverage. More cash on hand (*Cash liquidity*) should be associated with less leverage. The tax benefits of debt are higher with a higher *Marginal tax rate*. Among these control variables, only *Log Sales* and *Cash liquidity* have reliably significant coefficients of the expected sign. The other control variables are largely insignificant.

Tangible assets/ PP has positive point estimates and is significant in four out of the six regressions in Table 4. More importantly, the association between *Intangible assets/ PP* and leverage is positive and significant in five of the six model specifications.

Columns 1 and 3 have no industry controls. In columns 2 and 5, we include *Median industry leverage* and *Median industry market leverage*, respectively. Both variables are based on the Fama-French 48-industry classification. Frank and Goyal (2009) show that the industry median

[17] Our results are robust to clustering by industry using the Fama-French 48-industry classification, 2-digit SIC codes, or 4-digit SIC codes. Results are also robust to double clustering by both year and industry.
[18] We base our variable selection on Barclay and Smith (1995), Rajan and Zingales (1995), Graham (2000), Baker and Wurgler (2002), Frank and Goyal (2003), Korajczyk and Levy (2003), Hovakimiam, Hovakimian, and Tehranian (2004), Faulkender and Petersen (2006), Flannery and Rangan (2006), Lemmon, Roberts and Zender. (2008), and Campello and Giambona (2013).

leverage is one of the most reliable factors in explaining firms' capital structures. *Intangible assets/ PP* remains significant with slightly smaller point estimates with these industry control variables than in the regressions without industry controls. *Tangible assets/ PP* becomes insignificant in the book leverage regression and has meaningfully smaller point estimates in both the book and the market leverage regressions.

Gormley and Matsa (2014) advocate using fixed effects instead of group means or medians as control variables. Yet, industry fixed effects may not work well in our sample for at least three reasons. First, Gormley and Matsa (2014) explain that fixed effects are problematic when the independent variable, *Intangible assets/ PP* in our case, is measured with error. In that case, fixed effects increase the share of noise that is reflected in the estimates. Since the value of the intangible assets is estimated by the acquirer, and only includes identifiable intangible assets, it is measured with error. Second, Gormley and Matsa's recommendation assumes that the number of groups, industries in our case, is large relative to the number of observations per group, firms per industry in our case. With about 460 observations and 12 industries, this assumption does not hold true in our study. Using more than 12 industries, e.g., the Fama-French 48 industries, is impractical given our sample size. Three, the other advantages of our sample come at the cost of it being small relative to samples in other capital structure studies. Overall, fixed effects, like industry-year indicators, should be more applicable to large panel datasets. For small samples like ours, neither controlling for median industry leverage, nor using industry indicators is without problems, and not controlling for industry at all is likewise unsatisfactory. For these reasons, we pragmatically choose to primarily control for industry with the median industry leverage in the remainder of the paper, but we also frequently report results with industry indicators or without any industry controls. This approach lets us investigate the association between intangible assets and leverage,

acknowledging that some of this effect is likely captured by industry, but also allowing us to control for other industry-related effects.

With industry indicators in columns 3 and 6 of Table 4, the coefficients of *Tangible assets/ PP* are little changed. The point estimates of *Intangible assets/ PP* decline somewhat, and so does their significance. The coefficient is still significant at the 5%-level in the book leverage regression, but becomes insignificant in the market leverage regression.

Our results are sensitive to industry controls, and we regard this sensitivity as evidence that differences in tangible and intangible assets are an important reason why industry affects leverage. If tangible and intangible assets are an underlying reason why industry has significant effects in many capital structure analyses, it is not surprising that controlling for industry weakens the estimates for tangible and intangible assets. In fact, it provides interesting insights into why industry matters.

In general, the point estimates for *Intangible assets/ PP* are larger than those for *Tangible assets/ PP*. For example, in column 2 with *Leverage* as the dependent variable, the coefficient of *Intangible assets/ PP* is a highly significant 0.245 while that of *Tangible assets/ PP* is an insignificant 0.054. In column 5 with *Market leverage* as the dependent variable, the coefficients are significant 0.111 and 0.075, respectively. Overall, Table 4 shows that intangible assets are an important determinant of capital structure, apparently just as important as tangible assets. Intangible assets seem to support debt in similar ways as tangible assets do. Not surprisingly, lenders seem to be able to identify intangible assets and estimate their values even when firms do not report them in financial statements.

One reason why we need to interpret the point estimates with some caution is that tangible assets are likely measured with more accuracy than intangible assets. While our tangible asset

measure should capture all tangible assets, our estimates of intangible assets only include identifiable intangible assets, i.e., those intangible assets that are separable or arise from contractual or other legal rights. They do not include intangible assets like organizational competence or human capital. On the one hand, if identifiable intangible assets systematically capture a fraction of all intangible assets, the coefficients on our intangible asset variable can be biased upward. For example, if our measure only accounted for half of all intangible assets, the coefficient would be twice as high as it would be with accurate measurement. On the other hand, if the inaccuracies in our measurement of identifiable intangible are noise, then both the point estimates and significant levels should be biased downward.

Since tangible assets, identifiable intangible assets, and goodwill as fractions of the purchase price add up to one, we can only examine two of these three items at the same time. We choose to focus our tests on tangible assets and identifiable intangible assets because our hypotheses address these two variables. In light of the coefficients on tangible and identifiable intangible assets being significantly positive, it is obvious that goodwill would have significantly negative coefficients. We confirm this claim in untabulated tests. The negative correlation between goodwill (as a fraction of the purchase price) and leverage does not necessarily mean that goodwill by itself reduces leverage. Rather, this result can obtain because a large fraction of goodwill implies a low fraction of the sum of tangible assets and identifiable intangible assets. Our results show that tangible and identifiable intangible assets support debt, so the absence of tangible and identifiable intangible assets should have the opposite effect.

Firms that become targets and are eventually acquired may have unique unobservable characteristics that make their intangible assets particularly suitable to support debt. For example, they may have more identifiable intangible assets that may lead to upwardly biased coefficients.

We would like to address this potential sample selection bias with an appropriate econometric method. Yet, for identification purposes, we would need variables that predict which firms become targets and end up in our sample, and are unrelated to the leverage of target firms prior to being acquired. We conjecture that acquirers seek targets for growth and profitability while large target size should be an impediment to becoming a target. So, we could use variables like assets, profit margin, and sales growth as instruments. However, these three variables almost certainly affect leverage and therefore are not appropriate instruments. Unfortunately, we have not found appropriate instruments and suppose that finding them is likely impossible in this case. Still, we use our inappropriate instruments in untabulated Heckman analyses and our main results remain unchanged. We acknowledge that the lack of selection controls limits any claims of causality. Yet, we contend that even just the descriptive nature of our analyses provides important new insights.

5.2. Quantifying debt supported by tangible and intangible assets

Table 5 quantifies the debt supported by tangible and intangible assets, estimated with OLS, Tobit, Median regression, and an M-Estimator. The dependent variable is *Long-term debt* and our explanatory variables of interest are *Tangible assets* and *Intangible assets*. Note that all variables are in dollars, i.e., they are not scaled. We do not include additional independent variables, except year and industry indicators in column 2 because, due to the measurement in dollars instead of ratios, many are highly correlated with our two included variables.

The variables in dollars have large skewness. In addition to winsorizing, we limit the impact of outliers with the Median regression and the M-Estimator. The Robust M-Estimator aims to correct, in a robust manner, for outliers that, while valid, can significantly distort the estimation of classical least-squares estimators in a regression. We use Stata's *mregress* command (Verardi and Croux 2009) that, following Rousseeuw and Leroy (2003) and Huber (1964), allocates

different weights to different outliers to reduce the distortion on both the slope and intercept caused by the observations that are not located close to the true regression line. The practical implementation of the M-Estimator uses an iteratively reweighted OLS algorithm.

In Panel A, we use the entire sample. The OLS regressions show that a one dollar increase in intangible assets increases long-term debt by about $0.38 while a one dollar increase in tangible assets increases long-term debt by about $0.15. The magnitudes are similar in the Tobit estimation that accounts for the dependent variable always being nonnegative. In the Median and M-Estimator estimations, the estimates for *Tangible assets* are higher than in the OLS and Tobit estimations. The coefficients of *Intangible assets* are meaningfully smaller and become insignificant in the median regression.

In Panel B, we repeat the analysis but now only include observations with positive long-term debt. The results for the OLS, Tobit, and Robust M-Regression are similar to those for the entire sample. In the Median regression, the coefficient of *Intangible assets* almost doubles and becomes significant at the 5%-level. Overall, Table 5 shows that both tangible and intangible assets support debt. The relative magnitudes of the support vary, likely due to highly influential observations that affect the various types of analysis differently. Still, despite the shortcomings of the analysis, the results are largely consistent with the leverage ratio analysis and give us another way to gauge the magnitudes of the relations of tangible and intangible assets with leverage.

5.3. Analysis of identifiable assets

The intangible assets that we measure are only the so-called "identifiable" intangible assets. Clearly, all tangible assets are identifiable. Since tangible and identifiable intangible assets seem to have similar effects on leverage, the identifiability of the assets may be more important than the

distinction between tangible and intangible assets. For example, any asset would have to be at least identifiable to serve as collateral.

In Table 6, we estimate the same regressions as in columns 1 through 3 of Table 4 with one change: instead of including *Tangible assets/ PP* and *Intangible assets/ PP* separately, we combine both variables into *Identifiable assets/ PP*. As expected, *Identifiable assets/ PP* has significantly positive coefficients with magnitudes that are consistent with those in Table 4. The adjusted r–squares are also similar, indicating that we do not lose much information when combining tangible and identifiable intangible assets into one variable. Tangible and identifiable intangible assets are likely substitutes, i.e., when a firm does not have sufficient tangible assets to support its desired debt level, identifiable intangible assets can provide the necessary support.

5.4. Analysis of intangible asset components

We also separately examine the effects of the three components of identifiable intangible assets on leverage: technology-related, marketing-related, and other intangible assets. In columns 1 through 3 of Table 7, we replicate the regressions in columns 1 through 3 of Table 4 after decomposing identifiable intangible assets into these three components, measured as fractions of the purchase price.

All intangible asset components have positive point estimates. Technology-related intangible assets are significant with and without *Median industry leverage* as a control, but not with industry indicators. The "other" intangible assets are always significant, and the marketing-related intangible assets are never significant.

Next, we repeat the analyses after splitting the technology-related intangible assets into developed technology and in-process R&D, and the marketing-related intangible assets into tradenames and brands and customer-related assets. *Developed technology/ PP* is always

significantly positive, as is *In-process R&D/ PP*, except in the presence of industry indicators. The market-related intangible asset components are insignificant. Overall, these regressions suggest that technology-related and other intangible assets are the main drivers for the significantly positive relation between intangible assets and leverage.

5.5. Examples of intangible assets

A few examples from our sample can illustrate the actual intangible assets that stand behind our results. ICOS Corporation has $279 million of long-term debt and only few tangible assets. This relatively large amount of debt is likely supported by $1.7 billion of developed product technology that accounts for more than half of the company's market value of $3.2 billion. The entire $1.7 billion represents a joint venture between Lilly, the acquirer, and ICOS to sell the medication Cialis in North America and most of Europe. This intangible asset's proven profitability and low risk should allow it to support debt.

Guilford Pharmaceuticals has $132 million in long-term debt and only $76 million in tangible assets. Yet, its in-process R&D, made up of candidate compounds currently under development, is valued at $157 million, representing almost half of the company's market value. This in-process R&D seems to support at least a part of Guilford's debt. In contrast, in-process R&D in other companies does not support debt, likely because of the uncertainties associated with turning R&D into successful products. For example, AnorMED has $556 million of identifiable intangible assets, that account for 86% of its market value, of which $527 million are in-process R&D related to Mozobil, a promising late-stage product candidate in development for hematopoietic stem cell transplantations. Despite the "promise" of the treatment, AnorMED has zero debt. Similarly, Pharmion Corp. has $510 million of developed product rights and $1.7 billion of in-process R&D representing compounds under development by the company, together

comprising 71% of the its market value. Despite the $1.7 billion of in-process R&D, Pharmion has zero debt. Finally, Imclone Systems Inc.'s intangible assets consist largely of $1.1 billion of developed product technology and $4.7 billion of in-process R&D, primarily for two compounds in Phase II and III clinical testing. Its low amount of debt of $600 million is furthermore offset by $1 billion of cash and short-term investments. Overall, these examples reflect what we find in our statistical analyses. Both developed technologies and in-process R&D can support debt, but developed technologies do so substantially more reliably.

While marketing-related intangible assets seem to support debt only weakly in our statistical analysis, we see some examples of strong relations between marketing-related intangible assets and debt in our sample. UST Inc. has $1.1 billion of long-term debt and $1.6 billion of tangible assets. Far larger than the tangible assets are the $9.1 billion of marketing-related intangible assets that consist of indefinitely-lived trademarks, essentially UST's smokeless tobacco brand names. They account for 57% of UST's market value. These valuable trademarks, and the highly-profitable cash flows that UST generates through them, likely support a large portion of the company's debt. Similarly, AirGatePCS has $248 million of long-term debt and only $209 million of tangible assets. This substantial debt is likely supported by the $420 million of customer-related intangible assets that make up nearly half of AirGatePCS's market value. The $420 million consist of $210 million of "subscriber base in place at AirGate" and $210 million of "Sprint agreements in place at AirGate."

The category of other intangible assets has a strongly positive association with leverage in in our statistical tests, but is not particularly descriptive. An example where other intangible assets likely support debt is DexMedia. Its debt stands at $5.5 billion with only $820 million in tangible assets. Identifiable intangible assets amount to $8.9 billion of which $7.7 billion are non–compete

and publishing agreements with Qwest. This example is typical of the other category. Its intangible assets tend to be highly specific, frequently representing contractual and other legal rights. The high degree of specificity should make these assets highly transferable and relatively easy to collateralize. Therefore, it is not surprising that these intangible assets are significantly associated with leverage.

Of course, many companies in our sample have few intangible assets and still high leverage. Vanguard Health Systems, which owns and operates 28 hospitals, is an example. It has almost $3 billion of debt and only $108 million of intangible assets. Yet, it has $4.3 billion in tangible assets, much of it consisting of real estate holdings. Clearly, a company with plenty of liquid tangible assets does not need intangible assets to support its debt.

In sum, these examples illustrate to what degree different types of identifiable intangible assets support debt. While the examples only provide anecdotal evidence, they explain the findings of our statistical analyses.

5.6. Finite and indefinite life intangible assets

Accounting rules require the acquirer to categorize the intangible assets into finite and indefinite life. Finite life intangible assets are subject to mandatory amortization while indefinite life intangible assets require occasional impairment tests. In-process R&D is always initially classified as indefinite life until it results in developed technology that is then categorized as finite life and becomes subject to mandatory amortization.

Table 8 shows only small differences in the effects of finite life and indefinite life intangible assets on leverage. Both have significantly positive coefficients, except when we include industry indicators. While *Finite life intangible assets/ PP* is more significant, *Indefinite life intangible assets/ PP* has larger point estimates. A potential reason for this result is that a

substantial portion of indefinite life intangible assets consists of in-process R&D that is likely measured with more noise than finite life intangible assets like developed technology. Overall, the allocation to finite or indefinite life intangible assets is not overly important for our results. Therefore, any incentives that cause managers to favor allocations to indefinite over finite life intangibles assets should not affect our results.

5.7. Type of debt and debt maturity supported by intangible assets

Table 9 shows univariate analyses of various debt types (Panel A) and debt maturities (Panel B) after splitting the sample into low and high tangible asset intensity firms. Tangible asset intensity is high if *Tangible assets/ PP* is in the top tercile. We collect the various debt types from Capital IQ. In Panel A, firms with lower asset tangibility have relatively more term loans, bank debt, and convertible debt while they have relatively less unsecured and fixed-rate debt. These choices of debt types are well-suited for riskier and less transparent borrowers. Lack of collateralizable assets leaves unsecured debt as the only debt choice while uncertainty about the value of a firm's intangible assets favors convertible debt. With convertible debt, lenders benefit if the borrower's intangible assets turn out to be particularly valuable. This participation on the upside can compensate the lenders for the potential losses if the borrower's intangible assets turn out to be less valuable than expected. Bank debt usually allows the lender to monitor the borrower more frequently and more in-depth, and to make more timely adjustments to lending terms.

In Panel B, we assess whether the tangible asset intensity is related to debt maturities. The measures for debt maturity are (i) the ratio of debt in current liabilities (DLC in Compustat) to total long-term debt (DLC/ DLTT), (ii) the ratio of long-term debt due in next year (DD1) to total long-term debt, (iii) the ratio of long-term debt due in the next three years (DD1+DD2+DD3) to total long-term debt, and (iv) the ratio of long-term debt due in the next five years

(DD1+DD2+DD3+DD4+DD5) to total long-term debt. Firms with lower asset tangibility are more likely to have shorter-term debt, i.e., debt maturing within the next five years. Shorter-term debt is well-suited for riskier and less transparent borrowers. Again, it appears that intangible assets tend to support different types of debt than tangible assets. In sum, firms and their lenders seem to rationally choose debt types that best align with the tangible or intangible nature of the firms' assets.

6. Robustness tests

We assess the robustness of our results with many tests and report the most important ones in detail below.

6.1. Lagged leverage

One concern about our sample firms is that leverage can change meaningfully before an acquisition. If that was the case, it would be more difficult to argue that our results should apply to most firms and not just acquisition targets. Therefore, we repeat our main analysis with lagged values of leverage. First, note that the average *Leverage* changes only slightly over the three years before the acquisitions by declining from 0.178 to 0.160. Second, we replicate our main regressions, once with *Median industry leverage* as the industry control and alternatively with industry indicators, with *Leverage* lagged by one, two, and three years in Table 10. *Intangible assets/ PP* is always significantly positive. *Tangible assets/ PP* is only significant with the three-year lag. Interestingly, there is no decline in the significance levels of tangible and intangible assets for the greater lags, and there is even an increase for tangible assets. Overall, with the leverage of the firms being relatively stable over time, it is unlikely that changing capital structures before an acquisition drive our results.

6.2. Effects over time

We want to see whether our results are time-period specific. Table 11 splits our sample approximately in half by examining the period from 2002 to 2007 separately from 2008 to 2014. We repeat our main leverage regression with and without *Median industry leverage*, and with industry indicators. Compared to the earlier time period, *Intangible assets/ PP* has higher levels of significance in the more recent period. Point estimates are also higher, except for being about equal in the analysis with industry indicators. For example, with the median industry leverage control, the coefficient of *Intangible assets/ PP* increases from an insignificant 0.183 in 2002 to 2007 to a highly significant 0.325 in 2008 to 2014. This increase is even more remarkable given that the later subsample is smaller (186 versus 272 observations). The effects of time are less dramatic for *Tangible assets/ PP*. Its point estimates and significance levels have much smaller increases, and significance declines in the analysis with industry indicators. Overall, these findings show that as intangible assets continue to become more important in the economy, their effects on capital structure become more pronounced.

6.3. Alternative scaling

So far, we have scaled the tangible and intangible asset variables with the *Purchase price*, i.e., the amount the acquirer paid for the target. For better comparability with the existing literature, we scale these variables with the book value of assets and the enterprise value (market value of equity plus book value of debt) in columns 1 to 4 of Table 12. With these alternative denominators, three coefficients on the tangible assets are insignificant and one is significantly negative. The coefficients on the tangible assets here are difficult to interpret because the variable is essentially the ratio of fair value of tangible assets to book value of tangible assets.

The coefficients on the intangible assets, both the total, the technology-related component, and the other component, are significantly positive, but have smaller point estimates than before. One likely reason for the smaller coefficients is that the book value of assets and the enterprise value are on average smaller than the purchase price. These smaller denominators imply larger values for the tangible and intangible asset variables. Overall, scaling our main explanatory variables with book value of assets or enterprise value has only minor effects on our results.

7. Comparison with Peters and Taylor's (2017) intangible asset estimates

Peters and Taylor (2017) incorporate intangible assets in their analysis of the investment–*Tobin's q* relation. They use a perpetual-inventory method to measure the replacement costs of intangible assets. Essentially, their intangible assets equal the sum of past R&D and selling, general, and administrative (SG&A) spending, each depreciated with Bureau of Economic Analysis' industry-specific depreciation rates. Since most of the SG&A expenses are likely not investments into intangible capital, Peters and Taylor (2017) count only 30% of SG&A expenses towards their estimates of intangible assets.

Our measure of intangible assets and Peters and Taylor's (2017), "P&T's" going forward, measure differ in several ways. First, Peters and Taylor (2017) aim to measure all intangible assets while our measures capture identifiable intangible assets. To the extent that the collateralizability of intangible assets is important for them to support debt, identifiable intangible assets should matter more for capital structure than general, unidentifiable intangible assets. Second, P&T base their measures on internal expenditures for generating intangible assets while our measures come from audited fair value estimations in SEC filings that are based on arm's length transactions that incorporate the outcome of expenditures for intangible assets. For example, a pharmaceutical company may have spent $1 billion on the development of a drug, but may get acquired for $100

million if the drug's efficacy is lower than expected. Third, P&T's measures can be estimated for all Compustat firms and observed over time while our measures are only available for target firms at the point of acquisition. We can characterize our data as highly accurate estimates for a small number of firms of the subset of intangible assets that likely matter most for capital structure decisions, in contrast to P&T's substantially larger dataset of considerably less certain accuracy.

We begin with comparing ours to P&T's measure of intangible assets. Among our sample firms, the correlation between both estimates of intangible assets, scaled by *Assets*, is 0.31. As expected, P&T's intangible assets estimates are higher with a mean of $714 million compared to $629 million for our measure. Table 13 shows that these higher values are also reflected in various ratios of intangible assets to *Purchase price*, *Assets*, etc. For example, our intangible assets represent on average 98% of *Assets* while P&T's account for 104% of *Assets*. Overall, P&T's estimates of intangible assets have similar average magnitudes as ours. Yet, they differ meaningfully for individual firms so that the correlation between both measures is less than one third.

Finally, we check how well P&T's estimates of intangible assets perform in our leverage regressions. In columns 5 and 6 of Table 12, we use their measure of intangible assets and proxy for tangible assets with property, plant, and equipment (*PPE*). *P&T's Intangible assets* is insignificant when we run the regression for our sample. Using the Compustat universe for years 2002 to 2014, both *PPE* and *P&T's Intangible assets* have significantly positive coefficients, but the point estimate on *P&T's Intangible assets* is of a very small magnitude. Overall, P&T's intangible asset measure seems to capture, on average, a reasonable portion of our intangible asset measure, albeit at the cost of less accuracy as evidenced by its lower level of significance in the leverage regressions and its moderate correlation with our measure.

8. Conclusion

We show empirically that intangible assets have a robust positive relation with financial leverage even though these intangible assets are largely unreported in firms' financial statements and regulatory filings. Intangible assets support debt similarly to the way tangible assets do. Consistent with the nature of intangible assets, the level of asset tangibility affects the debt type and its maturity. Our paper's main innovation is that it circumvents the near impossibility (for outsiders) of accurately estimating the fair value of a firm's intangible assets by using a novel dataset that became available after a recent accounting rule change. While the dataset can only provide market value-based estimates of intangible assets for a small subset of firms, it is the first such dataset that allows a direct empirical examination of the relation between intangible assets and financial leverage. With the novel data, our study is the first that quantifies the relation of intangible assets and debt financing. Our results are important for the empirical research on capital structure because they are likely applicable to many, if not most, firms and they confirm that intangible assets, just like tangible assets, are one of the primary determinants of capital structure. Our findings challenge the inverse relation between intangible assets and financial leverage that the literature frequently infers.

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Appendix A: Asset substitution example

Suppose all agents are risk-neutral and the risk-free interest rate equals 0%. All payoffs are common knowledge and low and high states of the world are equally likely.

Without any collateral, a project has the following payoffs:

	Low	High	Expected
(R)isky	0	180	90
(S)afe	50	150	100

Clearly, project S has a higher net present value (NPV). Yet, depending on the amount of debt, managers will not always pick the higher NPV project. The reason is that switching to the riskier, lower NPV project can lead to higher expected payoffs for shareholders. Of course, lenders will anticipate such project switching and charge interest rates accordingly.

How much debt can the firm have and still choose project S? The condition is:

$180 - D \leq 150 - D + 50 - D$

$\Leftrightarrow D \leq 20$, where D is the face value of the debt.

With debt smaller or equal to 20, the firm picks the safe project, never defaults, and consequently the interest rate is 0%.

What happens if the face value of the debt is 50? Now,

$180 - 50 \leq 150 - 50$

$\Leftrightarrow 130 \leq 100$, which is never true.

With debt of 50, the firm always chooses the risky project. Because the firm defaults half the time and has zero to repay, it can only borrow 25 for a promised repayment (face value) of 50. Therefore, the interest rate is $50/25 - 1 = 100\%$.

We model collateral by increasing the minimum payoff in the low state and reducing the payoffs in the high state by the same amount of 30. An example for such collateral would be if the firm could acquire the know-how for a project either by buying patents (that can be easily sold in default and therefore can serve as collateral) instead investing in research and development (which might fail or be incomplete and therefore of little value in default). The payoffs with collateral are as follows:

	Low	High	Expected
(R)isky	30	150	90
(S)afe	80	120	100

Note that the expected payoffs remain the same. Now, how much debt can the firm have and still choose project S? The condition is:

$150 - D \leq 120 - D + 80 - D$

$\Leftrightarrow D \leq 50$, where D is the face value of the debt.

With debt smaller or equal to 50, the firm picks the safe project, never defaults, and consequently the interest rate is 0%.

What happens if the face value of the debt is 51? Now,

$150 - 51 \leq 200 - 102$

$\Leftrightarrow 99 \leq 100$, which is never true.

With debt of 51, the firm always chooses the risky project. Because the firm defaults half the time and has zero to repay, it can only borrow 40.5 [= (0.5) (30) + (0.5) (51)] for a promised repayment (face value) of 51. Therefore, the interest rate is 51/40.5 – 1 = 25.9%.

When we compare the projects without and with collateral, we see that with collateral the firm can borrow more at lower interest rates. Therefore, collateralizable assets should lead to lower interest rates and therefore larger amounts of debt.

Appendix B

Appendix B.1

Acquirer: Zhone Technologies Inc. Target: Sorrento Networks Corporation
Form 10-K for the year ending December 31, 2004
http://www.sec.gov/Archives/edgar/data/1101680/000119312505052811/d10k.htm

Purchased Technology

The Company recorded purchased technology related to acquisitions of $9.2 million, and $2.2 million during the years ended December 31, 2004, and 2003, respectively. To determine the values of purchased technology, the expected future cash flows of the existing developed technologies were discounted taking into account the characteristics and applications of the product, the size of existing markets, growth rates of existing and future markets, as well as an evaluation of past and anticipated product lifecycles.

(a) Sorrento Networks Corporation

In July 2004, the Company completed the acquisition of Sorrento Networks Corporation in exchange for total consideration of $98.0 million, consisting of common stock valued at $57.7 million, options and warrants to purchase common stock valued at $12.3 million, assumed liabilities of $27.0 million, and acquisition costs of $1.0 million. The Company acquired Sorrento to obtain its line of optical transport products and enhance its competitive position with cable operators. One of the Company's directors is a partner of a venture capital firm which is a significant stockholder of Zhone, and which also held warrants to purchase Sorrento common stock that were assumed by Zhone.

The purchase consideration was allocated to the fair values of the assets acquired as follows: **net tangible assets—$23.4 million, amortizable intangible assets—$14.8 million, purchased in-process research and development—$2.4 million, goodwill—$57.2 million** and deferred compensation—$0.2 million. The amount allocated to purchased in-process research and development was charged to expense during the third quarter of 2004, because technological feasibility had not been established and no future alternative uses for the technology existed. The estimated fair value of the purchased in-process research and development was determined using a discounted cash flow model, based on a discount rate which took into consideration the stage of completion and risks associated with developing the technology. Of the amount allocated to amortizable intangible assets, **$9.2 million was allocated to core technology**, which is being amortized over an estimated useful life of five years. The remaining **$5.6 million was allocated to customer relationships**, which is being amortized over an estimated useful life of four years.

Appendix B.2

Acquirer: K2 Inc. Target: Brass Eagle, Inc.
Form 10-K for the year ending December 31, 2003
http://www.sec.gov/Archives/edgar/data/6720/000119312504040670/d10k.htm

2003 Acquisitions

On December 16, 2003, K2 completed the acquisition of Brass Eagle, Inc. ("Brass Eagle") in a stock-for-stock exchange offer/merger transaction. Brass Eagle is a worldwide leader in the design, manufacture, marketing, and distribution of paintball products, including paintball markers, paintballs, and accessories.

On December 8, 2003, K2 completed the acquisition of Brass Eagle, Inc. ("Brass Eagle"), a designer, manufacturer and marketer of paintball products, including paintball markers, paintballs, and accessories in a stock-for-stock exchange offer/merger transaction. Under the terms of the merger, each outstanding share of Brass Eagle common stock was converted into 0.6036 shares of K2 common stock. Based on the number of common shares outstanding of Brass Eagle, approximately 4.5 million shares of K2's common stock were issued to the Brass Eagle shareholders, and the aggregate purchase price of the transaction was valued at approximately $78.4 million (excluding merger costs of approximately $3.4 million). The results of the operations of Brass Eagle have been included in the consolidated financial statements of K2 beginning with the date of the merger

The Brass Eagle transaction was accounted for under the purchase method of accounting; and, accordingly, the purchased assets and liabilities assumed were recorded at their estimated fair values at the date of the merger. The following table summarizes the total purchase price, estimated fair values of the assets acquired and liabilities assumed, and the resulting net intangible assets acquired at the date of the acquisition:

	In thousands	
Total purchase price, including estimated merger expenses and value of K2 stock options issued in exchange for Brass Eagle stock options outstanding (a)		$ **81,778** .
Total current assets	$ 51,027 .	
Property, plant and equipment	9,916 .	
Deferred taxes and other assets	11,485 .	
Net tangible assets acquired (b)	72,428 ..	
Total liabilities assumed (c)	56,016 .	
Net assets acquired (b) – (c) = (d)		**16,412** .
Net intangible assets acquired (a) – (d)		$ **65,366** .

Based on a valuation completed by K2 during 2003, **net intangible assets acquired** were allocated to **patents of $1.9 million** with an average life of 9 years; **order backlog of $0.2 million** with an average life of less than one year; **product trademarks of $0.3 million** with an average life of 5 years; **tradenames/trademarks with indefinite lives not subject to amortization of $24.6 million**; and **goodwill not subject to amortization of $38.4 million**.

Appendix C: Variable definitions

Variable	Description
Assets	Book value of total assets. Source: Compustat
Cash	Cash and cash-equivalents. Source: Compustat
Cash liquidity	*Cash*/ *Assets*. Source: Compustat
Customer-related	Customer-related assets, including backlog, customer contracts, and customer relationships. Source: PPA dataset based on 10-K or 10-Q of acquirer
Customer-related/ PP	*Customer-related/ Purchase price*
Debt in current liabilities/ total long-term debt	Debt in current liabilities (DLC in Compustat)/ total long-term debt (DLTT). Source: Compustat
Developed technology	Developed technology, including patents. Source: PPA dataset based on 10-K or 10-Q of acquirer
Developed technology/ PP	*Developed technology/ Purchase price*
Enterprise value	*Assets* – book value of common equity + market value of common equity, measured at end of last quarter before the acquisition announcement. Source: Compustat and Center for Research in Securities Prices (CRSP)
Finite life intangible assets	Finite life intangible assets. Source: PPA dataset based on 10-K or 10-Q of acquirer
Finite life intangible assets/ PP	Finite life intangible assets/ Purchase price
Goodwill	Goodwill. Source: PPA dataset based on 10-K or 10-Q of acquirer
Goodwill/ PP	*Goodwill*/ *Purchase price*
Identifiable assets/ PP	(*Tangible assets* + *Intangible assets*)/ *Purchase price*
In-process R&D	In-process research and development. Source: PPA dataset based on 10-K or 10-Q of acquirer
In-process R&D/ PP	*In-process R&D/ Purchase price*
Indefinite life intangible assets	Indefinite life intangible asset. Source: PPA dataset based on 10-K or 10-Q of acquirer
Indefinite life intangible assets/ PP	*Indefinite life intangible assets/ Purchase price*
Intangible assets	Intangible assets. Source: PPA dataset based on 10-K or 10-Q of acquirer
Intangible assets/ PP	*Intangible assets*/ *Purchase price*
Leverage	*Long-term debt*/ *Assets*. Source: Compustat
Leverage lag*x*	*Leverage* lagged by *x* years
Long-term debt	Book value of long-term debt. Source: Compustat
Long-term debt due in next year/ total long-term debt	Long-term debt due in the next year (DD1 in Compustat)/ total long-term debt (DLTT). Source: Compustat
Long-term debt due in next 3 years/ total long-term debt	Long-term debt due in the next three years (DD1+DD2+DD3 in Compustat) / total long-term debt (DLTT). Source: Compustat

Long-term debt due in next 5 years/ total long-term debt	Long-term debt due in the next five years (DD1+DD2+DD3+DD4+DD5 in Compustat) / total long-term debt (DLTT). Source: Compustat
Marginal tax rate	Graham's (2000) marginal tax rate. Source: John Graham, Duke University. https://faculty.fuqua.duke.edu/~jgraham/read.html
Market capitalization	Market value of common equity, measured at end of last quarter before the acquisition announcement. Source: CRSP
Market leverage	*Long-term debt*/ *Market capitalization*
Marketing-related	Marketing-related intangible assets, i.e., trademarks and trade names, including domain names, and customer-related assets, including backlog, customer contracts, and customer relationships. Source: PPA dataset based on 10-K or 10-Q of acquirer
Marketing-related/ PP	*Marketing-related*/ *Purchase price*
Market-to-book	Market value of common equity/ book value of common equity. Source: Compustat
Median industry leverage	Median *Leverage* of firm's industry using Fama French 48-industry classification
Median industry market leverage	Median *Market leverage* of firm's industry using Fama French 48-industry classification
Operating profitability	Earnings-before-interest-taxes-and-depreciation/ *Assets*. Source: Compustat
Other	Non-marketing-related and non-technology-related intangible assets. Source: PPA dataset based on 10-K or 10-Q of acquirer
Other/ PP	*Other*/ *Purchase price*
P&T's Identifiable assets	*P&T's Intangible assets* plus *PPE*. Source: Wharton Research Data Services
P&T's Intangible assets	Estimated from past R&D and SG&A spending as in Peters and Taylor (2017). Source: Wharton Research Data Services
PPE	Net property, plant and equipment. Source: Compustat
PPE/ assets	*PPE*/ *Assets*
Purchase price, abbreviated PP	*Tangible assets* + *Intangible assets* + *Goodwill*.
Sales	Net annual sales. Source: Compustat
Tangible assets	Tangible assets. Source: PPA dataset based on 10-K or 10-Q of acquirer
Tangible assets/ PP	*Tangible assets*/ *Purchase price*
Technology-related	Technology-related intangible assets, i.e., developed technology, including patents, and in-process research and development. Source: PPA dataset based on 10-K or 10-Q of acquirer
Technology-related/ PP	*Technology-related*/ *Purchase price*
Tradenames, brands	Trademarks and trade names, including domain names. Source: PPA dataset based on 10-K or 10-Q of acquirer
Tradenames, brands/ PP	*Tradenames, brands/ Purchase price*

Table 1: Descriptive statistics

The table reports descriptive statistics for our sample of 469 non-financial U.S. public firms that were acquired by U.S. public acquirers between 2002 and 2014 and compares them to the Compustat universe of 96,239 non-financial firm-year observations over the same period. Appendix C defines all variables. All variables, except for *Marginal tax rate*, are winsorized at the 1st and 99th percentile. ***, **, and * denote significance at the 1%, 5% and 10% levels for the differences in means between our sample and the Compustat universe.

	Compustat		Our sample				
	mean	median	mean	sd	p25	median	p75
Assets (billion $)	3.172	0.181	1.354 ***	4.706	0.073	0.227	0.775
Enterprise value (billion $)	4.724	0.285	2.211 ***	7.321	0.107	0.422	1.447
Market capitalization (billion $)	2.563	0.164	1.394 ***	4.874	0.067	0.292	0.922
Long-term debt (billion $)	0.700	0.006	0.368 ***	1.337	0.000	0.003	0.160
Leverage	0.196	0.097	0.160 ***	0.217	0.000	0.051	0.253
Leverage lag1	0.193	0.097	0.162 ***	0.212	0.000	0.061	0.262
Leverage lag2	0.194	0.099	0.164 ***	0.220	0.000	0.043	0.276
Leverage lag3	0.195	0.102	0.178	0.240	0.000	0.055	0.295
Median industry leverage	0.106	0.111	0.070 ***	0.096	0.004	0.008	0.117
Market leverage	0.119	0.042	0.102 **	0.148	0.000	0.022	0.163
Median industry market leverage	0.068	0.055	0.042 ***	0.063	0.001	0.004	0.066
Market-to-book	2.476	1.712	2.750 **	2.728	1.248	2.107	3.426
Sales (billion $)	2.098	0.151	1.019 ***	3.301	0.048	0.176	0.657
Operating profitability	-1.458	0.089	-0.284 ***	3.117	-0.030	0.085	0.178
Cash liquidity	0.216	0.107	0.296 ***	0.254	0.059	0.235	0.505
Cash (billion $)	0.268	0.018	0.198 *	0.773	0.013	0.048	0.128
Marginal tax rate	0.238	0.243	0.187 ***	0.151	0.020	0.210	0.341
PPE/ assets	0.269	0.178	0.194 ***	0.215	0.051	0.106	0.254
PPE (billion $)	0.982	0.028	0.428 ***	1.681	0.004	0.021	0.144
Observations	96,239			469			

Table 2: Purchase price allocation details

The table reports descriptive statistics of the purchase price allocation data for our sample of 469 non-financial U.S. public firms that were acquired by U.S. public acquirers between 2002 and 2014. Panel A displays the data in billions of dollars and Panel B as percentages of *Purchase price*. Appendix C defines all variables.

Panel A: In billions of dollars

	mean	sd	p25	median	p75	p90
Purchase price	3.046	9.965	0.177	0.629	2.070	6.034
Tangible assets	1.210	4.772	0.047	0.168	0.559	2.246
Intangible assets	0.852	3.660	0.025	0.106	0.460	1.500
Technology-related	0.335	2.628	0.000	0.009	0.077	0.422
Developed technology	0.229	1.936	0.000	0.005	0.050	0.230
In-process R&D	0.106	0.802	0.000	0.000	0.005	0.074
Marketing-related	0.342	1.175	0.004	0.029	0.174	0.728
Tradenames, brands	0.145	0.785	0.000	0.001	0.021	0.183
Customer-related	0.197	0.761	0.001	0.017	0.110	0.385
Other	0.175	1.192	0.000	0.000	0.008	0.097
Goodwill	0.984	2.649	0.046	0.220	0.836	1.962

Panel B: As percentages of *Purchase price*

	mean	sd	p25	median	p75	p90
Tangible assets/ PP	36.37	23.11	18.65	31.31	49.42	72.03
Intangible assets/ PP	25.44	17.57	11.72	23.56	34.54	48.49
Technology-related/ PP	10.89	16.34	0.00	4.33	14.84	31.21
Developed technology/ PP	7.30	10.83	0.00	2.50	11.05	20.78
In-process R&D/ PP	3.60	11.54	0.00	0.00	1.04	7.53
Marketing-related/ PP	11.34	11.34	2.72	8.51	16.36	27.48
Tradenames, brands/ PP	3.59	8.01	0.00	0.51	2.75	10.91
Customer-related/ PP	7.75	8.45	0.49	5.27	11.80	19.47
Other/ PP	3.18	9.17	0.00	0.00	1.35	10.75
Goodwill/ PP	38.19	20.12	22.85	38.64	52.62	64.53

Table 3: Sample distribution by industry

Panel A shows the distribution of our sample firms and the median industry leverage across the 12 Fama-French industries, excluding Finance, and compares it to the Compustat universe. Panels B and C show the distributions, by industry, of the purchase price allocation components and intangible asset components, respectively. Appendix C defines all variables.

Panel A: Distribution of firms across industries

	Compustat			Our sample		
	N	%	Median industry leverage	N	%	Median industry leverage
Consumer non-durables	5,346	5.6	15.5	18	3.8	13.9
Consumer durables	2,638	2.7	10.2	9	1.9	8.5
Manufacturing	10,089	10.5	15.4	29	6.2	14.1
Energy	5,101	5.3	17.7	16	3.4	17.7
Chemicals and allied products	2,727	2.8	18.3	10	2.1	19.1
Business equipment	22,248	23.1	0.8	193	41.2	0.5
Telecommunications	4,607	4.8	26.0	21	4.5	26.0
Utilities	4,262	4.4	29.4	6	1.3	29.4
Shops	9,749	10.1	13.7	35	7.5	12.2
Healthcare	12,679	13.2	2.7	73	15.6	2.8
Other	16,793	17.4	10.7	59	12.6	10.7
All	96,239	100	10.6	469	100	7.0

Panel B: Purchase price allocation components by industry

Percentage of Purchase price	Tangible assets	Intangible assets	Goodwill	Tech-nology-related	Market-ing-related	Other
Consumer non-durables	31.0	35.6	33.4	0.0	30.6	5.1
Consumer durables	47.3	20.0	32.7	5.9	12.9	1.2
Manufacturing	46.9	17.7	35.5	2.9	13.2	1.5
Energy	65.6	15.2	19.2	0.4	4.8	10.0
Chemicals and allied products	55.1	18.0	26.8	3.9	9.9	4.2
Business equipment	31.3	24.9	43.8	12.1	10.9	1.9
Telecommunications	41.0	26.3	32.7	0.0	12.8	13.5
Utilities	79.6	1.0	19.4	0.0	1.0	0.0
Shops	39.6	20.3	40.1	1.9	15.3	3.0
Healthcare	24.3	40.5	35.2	31.8	5.7	2.9
Other	43.7	19.3	37.0	3.3	13.0	3.0
All	36.4	25.4	38.2	10.9	11.3	3.2

Table 3 (continued)

Panel C: Intangible asset components by industry

Percentage of Purchase price	Tech-nology-related	Developed technology	In-process R&D	Market-ing-related	Trade-names, brands	Customer-related	Other
Consumer non-durables	0.0	0.0	0.0	30.6	23.9	6.6	5.1
Consumer durables	5.9	5.9	0.0	12.9	6.5	6.3	1.2
Manufacturing	2.9	2.3	0.6	13.2	6.1	7.2	1.5
Energy	0.4	0.3	0.1	4.8	0.4	4.4	10.0
Chemicals and allied products	3.9	3.5	0.4	9.9	2.9	7.0	4.2
Business equipment	12.1	10.4	1.7	10.9	1.7	9.2	1.9
Telecommunications	0.0	0.0	0.0	12.8	0.3	12.5	13.5
Utilities	0.0	0.0	0.0	1.0	0.1	0.9	0.0
Shops	1.9	1.0	0.9	15.3	8.4	6.9	3.0
Healthcare	31.8	14.8	17.1	5.7	1.6	4.1	2.9
Other	3.3	2.2	1.1	13.0	4.1	8.9	3.0
All	10.9	7.3	3.6	11.3	3.6	7.7	3.2

Table 4: Leverage regressions

The table shows OLS regressions. *Leverage* is the dependent variable in columns 1 through 3, and *Market leverage* in columns 4 through 6. Appendix C defines all variables. "Log" in front of the variable name indicates the natural logarithm of the variable. All regressions have intercepts and year indicators. Industry indicators are based on the Fama-French 12-industry classification. Eicker-Huber-White-Sandwich heteroskedasticity-robust standard errors clustered by industry are in parentheses. ***, **, and * denote significance at 1%, 5% and 10% levels, respectively.

Dependent variable	Leverage			Market leverage		
	(1)	(2)	(3)	(4)	(5)	(6)
Purchase price allocation						
Tangible assets/ PP	0.130***	0.054	0.073	0.118***	0.075*	0.082*
	(0.037)	(0.053)	(0.055)	(0.030)	(0.038)	(0.040)
Intangible assets/ PP	0.268***	0.245***	0.161**	0.121**	0.111***	0.056
	(0.068)	(0.055)	(0.078)	(0.047)	(0.038)	(0.058)
Control variables						
Log Market capitalization	0.002	-0.001	-0.006	-0.013	-0.015	-0.020**
	(0.012)	(0.014)	(0.014)	(0.008)	(0.009)	(0.010)
Market-to-book	0.007	0.006	0.006	0.001	0.001	0.001
	(0.005)	(0.005)	(0.006)	(0.002)	(0.002)	(0.002)
Log Sales	0.028*	0.020	0.032**	0.031***	0.027**	0.036***
	(0.016)	(0.016)	(0.015)	(0.009)	(0.010)	(0.009)
Operating profitability	-0.002	-0.001	-0.001	-0.003***	-0.003**	-0.003**
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
Cash liquidity	-0.303***	-0.225***	-0.243***	-0.189***	-0.150***	-0.157***
	(0.063)	(0.050)	(0.060)	(0.044)	(0.037)	(0.040)
Marginal tax rate	-0.120	-0.136*	-0.063	-0.049	-0.054	-0.004
	(0.079)	(0.073)	(0.069)	(0.051)	(0.047)	(0.044)
Median industry leverage		0.666***				
		(0.187)				
Median industry market leverage					0.534**	
					(0.201)	
Industry indicators	no	no	yes	no	no	yes
Adjusted R^2	0.206	0.261	0.263	0.266	0.300	0.322
Observations	458					

Table 5: Quantifying debt supported by tangible and intangible assets

The table reports OLS, Tobit, Median and Robust M-Regression estimations. The dependent variable is *Long-term debt*. The only independent variables are *Tangible asset* and *Intangible assets*, except for year and industry indicators in column 2. We do not include additional explanatory variables because of the substantial correlations of the variables measured in dollar amounts. Panel A includes all observations and Panel be only those with *Long-term debt* larger than zero. Appendix C defines all variables. All estimations have intercepts. Robust standard errors are in parentheses. Industry indicators are based on the Fama-French 12-industry classification. ***, **, and * denote significance at 1%, 5% and 10% levels, respectively.

Panel A: Entire sample

Dependent variable	Long-term debt				
	(1)	(2)	(3)	(4)	
Estimation method	OLS		Tobit	Median	Robust M-Regression
Tangible assets	0.158***	0.151***	0.169***	0.255***	0.257***
	(0.055)	(0.053)	(0.054)	(0.059)	(0.001)
Intangible assets	0.381***	0.355***	0.414***	0.075	0.080***
	(0.136)	(0.125)	(0.140)	(0.056)	(0.003)
Year and industry indicators	no	yes	no	no	no
Adjusted R^2 or Pseudo R^2	0.635	0.669	0.062	0.313	0.993
Observations			465		

Panel B: Subsample with *Long-term debt* > 0

Dependent variable	Long-term debt				
	(1)	(2)	(3)	(4)	
Estimation method	OLS		Tobit	Median	Robust M-Regression
Tangible assets	0.152***	0.146***	0.152***	0.254***	0.259***
	(0.055)	(0.052)	(0.055)	(0.073)	(0.002)
Intangible assets	0.403***	0.376***	0.403***	0.139**	0.146***
	(0.142)	(0.130)	(0.142)	(0.063)	(0.005)
Year and industry indicators	no	yes	no	no	no
Adjusted R^2 or Pseudo R^2	0.637	0.673	0.058	0.3704	0.990
Observations			311		

Table 6: Identifiable assets

The table reports OLS regressions. The dependent variable is *Leverage*. Appendix C defines all variables. "Log" in front of the variable name indicates the natural logarithm of the variable. All regressions have intercepts and year indicators. Industry indicators are based on the Fama-French 12-industry classification. Eicker-Huber-White-Sandwich heteroskedasticity-robust standard errors clustered by industry are in parentheses ***, **, and * denote significance at 1%, 5% and 10% levels, respectively.

Dependent variable	Leverage		
	(1)	(2)	(3)
Purchase price allocation:			
Identifiable assets	0.165***	0.107***	0.098**
	(0.026)	(0.034)	(0.043)
Control variables			
Log Market capitalization	0.007	0.007	-0.002
	(0.013)	(0.015)	(0.015)
Market-to-book	0.008	0.007	0.006
	(0.005)	(0.005)	(0.006)
Log Sales	0.022	0.012	0.028*
	(0.015)	(0.016)	(0.015)
Operating profitability	-0.002	-0.002	-0.002
	(0.002)	(0.002)	(0.002)
Cash liquidity	-0.304***	-0.233***	-0.248***
	(0.060)	(0.048)	(0.061)
Marginal tax rate	-0.142	-0.165*	-0.075
	(0.087)	(0.084)	(0.073)
Median Industry Leverage		0.615***	
		(0.174)	
Industry indicators	no	no	yes
Adjusted R^2	0.200	0.247	0.262
Observations		458	

Table 7: Purchase price allocation components

The table reports OLS regressions. The dependent variable is *Leverage*. Appendix C defines all variables. "Log" in front of the variable name indicates the natural logarithm of the variable. All regressions have intercepts and year indicators. Industry indicators are based on the Fama-French 12-industry classification. Eicker-Huber-White-Sandwich heteroskedasticity-robust standard errors clustered by industry are in parentheses ***, **, and * denote significance at 1%, 5% and 10% levels, respectively.

Dependent variable	Leverage					
	(1)	(2)	(3)	(4)	(5)	(6)
Purchase price allocation:						
Tangible assets/ PP	0.119***	0.038	0.078	0.115***	0.038	0.080*
	(0.039)	(0.058)	(0.052)	(0.035)	(0.052)	(0.046)
Technology-related/ PP	0.215***	0.252***	0.106			
	(0.046)	(0.042)	(0.084)			
Developed technology/ PP				0.177**	0.232***	0.115*
				(0.080)	(0.084)	(0.066)
In-process R&D/ PP				0.264***	0.293***	0.094
				(0.079)	(0.072)	(0.146)
Marketing-related/ PP	0.180	0.127	0.143			
	(0.147)	(0.128)	(0.134)			
Tradenames, brands/ PP				0.134	0.044	0.140
				(0.190)	(0.147)	(0.207)
Customer-related/ PP				0.216	0.208	0.148
				(0.211)	(0.179)	(0.145)
Other/ PP	0.459***	0.342***	0.285***	0.454***	0.341***	0.288***
	(0.104)	(0.086)	(0.083)	(0.110)	(0.090)	(0.086)
Control variables						
Log Market capitalization	0.001	-0.004	-0.005	0.000	-0.004	-0.004
	(0.011)	(0.013)	(0.014)	(0.012)	(0.014)	(0.014)
Market-to-book	0.007	0.006	0.006	0.007	0.006	0.006
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Log Sales	0.028**	0.023	0.030**	0.029**	0.024	0.030*
	(0.014)	(0.015)	(0.015)	(0.014)	(0.015)	(0.015)
Operating profitability	-0.002	-0.001	-0.002	-0.001	0.000	-0.002
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
Cash liquidity	-0.293***	-0.228***	-0.239***	-0.291***	-0.226***	-0.239***
	(0.051)	(0.047)	(0.058)	(0.051)	(0.047)	(0.058)
Marginal tax rate	-0.117	-0.119	-0.071	-0.113	-0.115	-0.072
	(0.087)	(0.074)	(0.070)	(0.086)	(0.073)	(0.072)
Median industry leverage		0.658***			0.668***	
		(0.188)			(0.182)	
Industry indicators	no	no	yes	no	no	yes
Adjusted R^2	0.213	0.263	0.263	0.210	0.261	0.260
Observations	458					

Table 8: Finite and indefinite life intangible assets

The table shows OLS regressions. *Leverage* is the dependent variable in all columns. Appendix C defines all variables. "Log" in front of the variable name indicates the natural logarithm of the variable. All regressions have intercepts and year indicators. Industry indicators are based on the Fama-French 12-industry classification. Eicker-Huber-White-Sandwich heteroskedasticity-robust standard errors clustered by industry are in parentheses. ***, **, and * denote significance at 1%, 5% and 10% levels, respectively.

Dependent variable	Leverage		
	(1)	(2)	(3)
Purchase price allocation:			
Tangible assets/ PP	0.135***	0.057	0.078
	(0.035)	(0.056)	(0.055)
Finite life intangible assets/ PP	0.245***	0.248***	0.153
	(0.062)	(0.059)	(0.091)
Indefinite life intangible assets/ PP	0.381**	0.260*	0.242
	(0.171)	(0.141)	(0.157)
Control variables			
Log Market capitalization	0.003	-0.001	-0.006
	(0.012)	(0.014)	(0.014)
Market-to-book	0.007	0.006	0.006
	(0.005)	(0.006)	(0.006)
Log Sales	0.026*	0.021	0.031**
	(0.015)	(0.016)	(0.015)
Operating profitability	-0.002	-0.001	-0.001
	(0.002)	(0.002)	(0.002)
Cash liquidity	-0.300***	-0.225***	-0.244***
	(0.064)	(0.050)	(0.060)
Marginal tax rate	-0.128	-0.134*	-0.065
	(0.076)	(0.068)	(0.065)
Median industry leverage		0.661***	
		(0.203)	
Industry indicators	no	no	yes
Adjusted R^2	0.208	0.260	0.263
Observations		458	

Table 9: Debt type and maturity by tangible asset intensity

The table shows univariate analyses of various debt types (Panel A) and debt maturities (Panel B) after splitting the sample by tangible asset intensity. We classify tangible asset intensity as high if it is in the top tercile of *Tangible assets/ PP*. The debt types are from Capital IQ and the debt maturities from Compustat. Appendix C defines all variables. ***, **, and * denote significance at 1%, 5% and 10% levels, respectively.

Panel A: Debt types

Tangible assets/ PP	All	Bottom two terciles	Top tercile	Difference	
Tangible asset intensity		low	high	low-high	
Type of debt as % of total debt					
Long-term debt (including capital leases)	73.2	71.9	75.9	-4.0	
Secured debt	53.2	55.0	49.6	5.4	
Unsecured debt	47.1	45.0	51.1	-6.1	*
Term loans	25.0	29.0	17.2	11.8	***
Fixed-rate debt	43.6	39.5	51.5	-11.9	***
Variable-rate debt	34.2	35.6	31.5	4.1	
Bank debt	40.5	43.8	33.8	10.0	**
Commercial paper	0.5	0.3	0.9	-0.6	
Convertible debt	15.4	17.3	11.7	5.5	**
Revolving debt	18.9	18.9	18.9	0.0	
Observations	412	273	139		

Panel B: Debt maturity

Tangible assets/ PP	All	Bottom two terciles	Top tercile	Difference	
Tangible asset intensity		low	high	low-high	
Debt in current liabilities/ total long-term debt	34.2	39.8	23.2	16.5	***
Long-term debt due in next year/ total long-term debt	18.9	22.4	11.9	10.4	***
Long-term debt due in next 3 years/ total long-term debt	35.0	37.8	29.3	8.6	**
Long-term debt due in next 5 years/ total long-term debt	38.8	40.7	35.0	5.7	*
Observations	420	279	141		

Table 10: Lagged leverage regressions

The table shows OLS regressions. The dependent variable is *Leverage lag1* in columns 1 and 2, *Leverage lag2* in columns 3 and 4, and *Leverage lag3* in columns 5 and 6. Appendix C defines all variables. "Log" in front of the variable name indicates the natural logarithm of the variable. All regressions have intercepts and year indicators. Industry indicators are based on the Fama-French 12-industry classification. Eicker-Huber-White-Sandwich heteroskedasticity-robust standard errors clustered by industry are in parentheses. ***, **, and * denote significance at 1%, 5% and 10% levels, respectively.

Dependent variable	Leverage lag1		Leverage lag2		Leverage lag3	
	(1)	(2)	(3)	(4)	(5)	(6)
Purchase price allocation						
Tangible assets/ PP	0.050	0.052	0.088	0.124	0.152**	0.145**
	(0.071)	(0.067)	(0.080)	(0.084)	(0.066)	(0.061)
Intangible assets/ PP	0.276***	0.165**	0.224***	0.137**	0.284***	0.209**
	(0.081)	(0.065)	(0.066)	(0.058)	(0.079)	(0.090)
Control variables						
Log Market capitalization	-0.016	-0.029	-0.006	-0.010	-0.011	-0.017**
	(0.018)	(0.019)	(0.011)	(0.012)	(0.007)	(0.008)
Market-to-book	0.001	0.002	0.007	0.008	0.003	0.003
	(0.008)	(0.008)	(0.007)	(0.007)	(0.004)	(0.004)
Log Sales	0.029	0.051**	0.023*	0.034**	0.027**	0.037***
	(0.021)	(0.021)	(0.013)	(0.014)	(0.011)	(0.010)
Operating profitability	-0.003	-0.008	0.002	0.000	0.001	-0.003
	(0.007)	(0.010)	(0.005)	(0.008)	(0.006)	(0.006)
Cash liquidity	-0.223***	-0.235***	-0.219***	-0.254***	-0.235***	-0.218***
	(0.076)	(0.084)	(0.064)	(0.078)	(0.063)	(0.072)
Marginal tax rate	-0.074	0.025	-0.025	0.054	-0.121	-0.053
	(0.084)	(0.083)	(0.084)	(0.082)	(0.081)	(0.075)
Median industry leverage	0.795***		0.757***		0.765***	
	(0.239)		(0.264)		(0.237)	
Industry indicators	no	yes	no	yes	no	yes
Adjusted R^2	0.228	0.249	0.251	0.261	0.288	0.285
Observations	439		437		411	

Table 11: Leverage regressions split by time

The table reports OLS regressions after splitting the sample approximately in half. The dependent variable is *Leverage*. Appendix C defines all variables. "Log" in front of the variable name indicates the natural logarithm of the variable. All regressions have intercepts and year indicators. Industry indicators are based on the Fama-French 12-industry classification. Eicker-Huber-White-Sandwich heteroskedasticity-robust standard errors clustered by industry are in parentheses. ***, **, and * denote significance at 1%, 5% and 10% levels, respectively.

Dependent variable	Leverage					
Time period	2002 to 2007	2008 to 2014	2002 to 2007	2008 to 2014	2002 to 2007	2008 to 2014
	(1)	(2)	(3)	(4)	(5)	(6)
Purchase price allocation:						
Tangible assets/ PP	0.122*	0.167***	0.014	0.133*	0.052	0.132
	(0.057)	(0.044)	(0.065)	(0.058)	(0.030)	(0.082)
Intangible assets/ PP	0.235	0.320***	0.183	0.325***	0.172	0.165*
	(0.131)	(0.064)	(0.123)	(0.062)	(0.112)	(0.078)
Control variables						
Log Market capitalization	0.003	0.002	-0.005	0.005	-0.010	0.008
	(0.007)	(0.010)	(0.004)	(0.009)	(0.011)	(0.021)
Market-to-book	0.002	0.015	0.000	0.014	0.001	0.013
	(0.008)	(0.009)	(0.007)	(0.010)	(0.007)	(0.011)
Log Sales	0.024	0.041**	0.016	0.032*	0.031*	0.030
	(0.013)	(0.012)	(0.011)	(0.015)	(0.013)	(0.026)
Operating profitability	-0.002	-0.020	-0.001	-0.018	-0.002	-0.003
	(0.002)	(0.011)	(0.002)	(0.011)	(0.003)	(0.016)
Cash liquidity	-0.345***	-0.240*	-0.250***	-0.185	-0.269***	-0.217
	(0.035)	(0.116)	(0.049)	(0.121)	(0.068)	(0.140)
Marginal tax rate	-0.208**	0.034	-0.219**	0.014	-0.156	0.097
	(0.082)	(0.101)	(0.077)	(0.112)	(0.104)	(0.067)
Median industry leverage			0.851***	0.474		
			(0.160)	(0.274)		
Industry indicators	no	no	no	no	yes	yes
Adjusted R^2	0.200	0.234	0.280	0.264	0.220	0.362
Observations	272	186	272	186	272	186

Table 12: Scaling by assets and enterprise value

The table shows OLS regressions. The dependent variable is *Leverage*. Columns 1, 2, 5, and 6 scale the tangible and intangible asset variables by *Assets*. Columns 3 and 4 scale by *Enterprise value*. Columns 1 through 5 use the PPA sample and column 6 the Compustat universe for the years 2002 to 2014. Appendix C defines all variables. "Log" in front of the variable name indicates the natural logarithm of the variable. All regressions have intercepts and year indicators. Eicker-Huber-White-Sandwich heteroskedasticity-robust standard errors clustered by industry are in parentheses. ***, **, and * denote significance at 1%, 5% and 10% levels, respectively.

Dependent variable	Leverage					
	(1)	(2)	(3)	(4)	(5)	(6)
Scaled by	Assets		Enterprise value		Assets	
Purchase price allocation						
Tangible assets	-0.018	-0.022*	-0.026	-0.027		
	(0.012)	(0.013)	(0.021)	(0.021)		
Intangible assets	0.024***		0.065**			
	(0.006)		(0.031)			
PPE					0.189**	0.120***
					(0.082)	(0.034)
P&T's Intangible assets					0.013	0.000**
					(0.008)	0.000
Technology-related		0.025***		0.068*		
		(0.006)		(0.034)		
Marketing-related		0.013		0.015		
		(0.019)		(0.056)		
Other		0.081**		0.159**		
		(0.037)		(0.069)		
Control variables						
Log Market capitalization	-0.005	-0.006	-0.003	-0.005	0.001	0.000
	(0.016)	(0.015)	(0.016)	(0.015)	(0.015)	(0.006)
Market-to-book	0.004	0.004	0.005	0.005	0.006	-0.009***
	(0.006)	(0.005)	(0.006)	(0.005)	(0.005)	(0.002)
Log Sales	0.024	0.027	0.022	0.024	0.020	0.004
	(0.018)	(0.017)	(0.018)	(0.017)	(0.015)	(0.006)
Operating profitability	0.000	-0.001	-0.002	-0.002	-0.003	-0.002***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	0.000
Cash liquidity	-0.218***	-0.213***	-0.219***	-0.218***	-0.163***	-0.183***
	(0.052)	(0.051)	(0.055)	(0.052)	(0.058)	(0.025)
Marginal tax rate	-0.136	-0.134	-0.140*	-0.134	-0.154*	-0.156***
	(0.081)	(0.083)	(0.080)	(0.084)	(0.082)	(0.044)
Median industry leverage	0.687***	0.670***	0.700***	0.677***	0.500**	0.291***
	(0.166)	(0.163)	(0.168)	(0.171)	(0.204)	(0.076)
Adjusted R^2	0.254	0.253	0.248	0.246	0.260	0.127
Observations	458					61,796

Table 13: Comparison with Peters and Taylor's (2017) identifiable assets

Panel A shows the distributions of accounting, purchase price allocation, and Peters and Taylor's (2017) estimates of tangible and intangible assets in millions of dollars for our sample of 469 non-financial U.S. public firms that were acquired by U.S. public acquirers between 2002 and 2014. Panel B shows the data in various ratios. Appendix C defines all variables.

Panel A: Descriptive statistics in millions of dollars

Variable	mean	p25	median	p75
PPE	428.1	4.4	20.7	144.3
Tangible assets	1,122.8	46.8	168.1	559.1
Intangible assets	628.9	25.1	106.0	460.0
P&T's Intangible assets	713.6	56.2	144.2	407.3
Ours – P&T's Intangible assets	138.9	-115.1	-22.9	58.2

Panel B: Descriptive statistics of ratios

Numerator	Denominator	mean	sd	p25	median	p75
PPE	Assets	0.194	0.216	0.051	0.106	0.254
Tangible assets	PP	0.364	0.231	0.186	0.313	0.494
Tangible assets	Assets	0.873	0.657	0.561	0.808	1.059
Tangible assets	Enterprise value	0.527	0.435	0.262	0.468	0.693
Intangible assets	PP	0.254	0.176	0.117	0.236	0.345
Intangible assets	Assets	0.976	1.601	0.235	0.530	1.001
Intangible assets	Enterprise value	0.401	0.376	0.158	0.322	0.512
P&T's Intangible assets	PPE	0.773	0.274	0.700	0.893	0.955
P&T's Intangible assets	Assets	1.041	1.322	0.470	0.781	1.221
P&T's Intangible assets	Enterprise value	0.617	0.628	0.214	0.450	0.779
P&T's Intangible assets	P&T's Identifiable assets	0.426	0.190	0.320	0.439	0.550
P&T's Intangible assets	PP	0.487	0.747	0.143	0.315	0.552
P&T's Intangible assets	PP's Identifiable assets	0.872	1.344	0.249	0.552	0.974

Figure 1: Cost of debt with and without collateral
This figure shows the cost of debt with and without collateral.

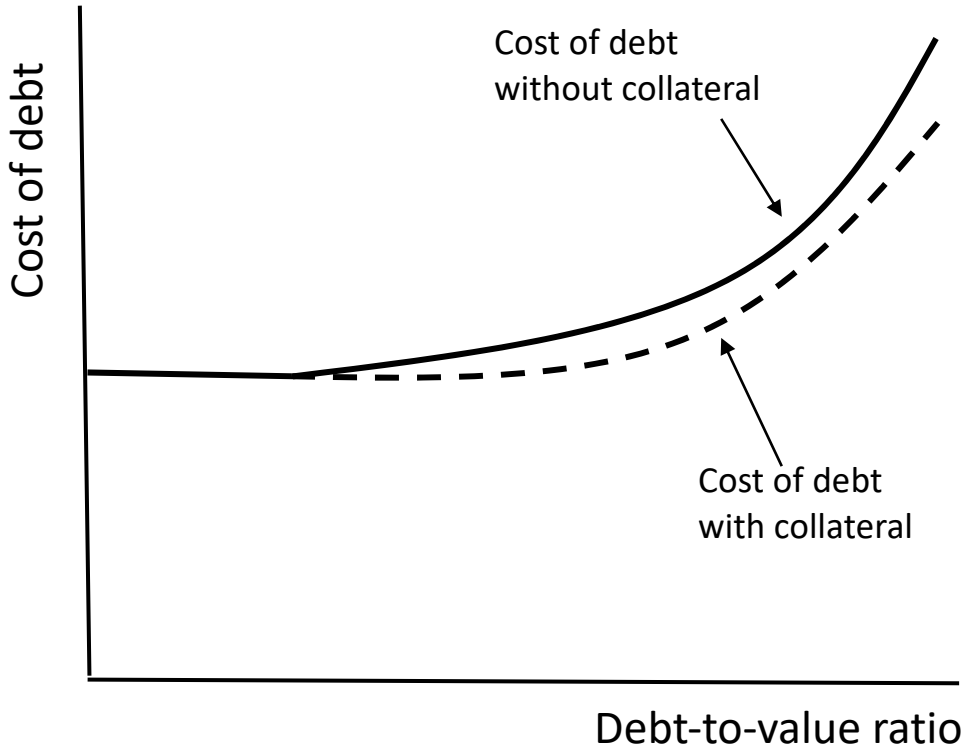

Figure 2: Purchase price allocation

This figure shows the composition of the purchase price. It is modified from a figure in the Houlihan and Lokey 2011 Purchase Price Allocation Study.