Measuring Intangible Capital with Market Prices *

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Despite the importance of intangibles in today's economy, current standards prohibit the capitalization of internally created knowledge and organizational capital, resulting in a downward bias of reported assets. As a result, researchers estimate this value by capitalizing prior flows of R&D and SG&A. In doing so, a set of capitalization parameters, i.e. the R&D depreciation rate and the fraction of SG&A that represents a long-lived asset, must be assumed. Parameters now in use are derived from models with strong assumptions or are ad hoc. We develop a capitalization model that motivates the use of market prices of intangibles to estimate these parameters. Two settings provide intangible asset values: (1) publicly traded equity prices and (2) acquisition prices. We use these parameters to estimate intangible capital stocks and subject them to an extensive set of diagnostic analyses that compare them with stocks estimated using existing parameters. Intangible stocks developed from exit price parameters outperform both stocks developed by publicly traded parameters and those stocks developed with existing estimates.

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> In the early days of Microsoft, I felt like I was explaining something completely foreign to people. Our business plan involved a different way of looking at assets than investors were used to. They couldn't imagine what returns we would generate over the long term. The idea today that anyone would need to be pitched on why software is a legitimate investment seems unimaginable, but a lot has changed since the 1980s. It's time the way we think about the economy does, too.
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> - Bill Gates (2018)[1]

Corporate investment has transformed over the last few decades, with U.S. firms spending less on tangible assets and more on intangibles related to knowledge and organizational capacity (Figure 1). This reduction in tangible capital investment, along with the weaker connection between investment and firm valuation, is described as a "broader investment puzzle" by Gutiérrez and Philippon (2017) and Crouzet and Eberly (2019). A shared conclusion of both papers is that standard investment measures fail to capture the growing importance of intangible assets, resulting in a downward bias in the recorded book values of invested capital. This bias has grown over time, as evidenced by the dramatic upward trend in market-to-book ratios. This paper proposes a new method to estimate the parameters of the capitalization process central to any estimate of intangible capital stocks.

Beyond academia, reliable measures of intangible capital are important for capital markets and financial managers. For instance, numerous studies have provided evidence of mispriced equity for firms with higher levels of intangible capital, which could lead to suboptimal allocations of resources.[2] In debt markets, research has documented that banks are less willing to lend to firms with higher information asymmetry and less certain liquidation value, two primary characteristics of intangible intensive firms.[3] In corporate finance, financial managers making capital budgeting decisions must accurately estimate book values of intangible capital to calculate returns to intangible capital (Hall, Mairesse, and Mohnen, 2010).

Accounting rules for intangibles originated in 1974 when intangible investments were only a small proportion of the economy, and they have not changed, despite a fundamental change towards

[1] `http://bit.ly/2Xk8qEU`

[2] A partial list of these studies includes Daniel and Titman (2006); Eberhart, Maxwell, and Siddique (2004); Aksoy, Cooil, Groening, Keiningham, and Yalçın (2008); Edmans (2011); Eisfeldt and Papanikolaou (2013).

[3] Williamson (1988); Shleifer and Vishny (1992); Loumioti (2012); Mann (2018)

intangibles as economic value drivers. Specifically, a firm's internal Research and Development (R&D) costs and Selling, General, and Administrative (SG&A) activities are immediately recorded as expenses and thus do not appear on its balance sheet. This lack of capitalization reduces the informativeness of accounting book values in explaining market values (e.g., Lev and Zarowin, 1999). To resolve this problem, researchers in economics and finance estimate the off-balance sheet intangible capital with accumulated flows of R&D (Bernstein and Nadiri, 1988; Chan, Lakonishok, and Sougiannis, 2001; Hirshleifer, Hsu, and Li, 2013), SG&A (Eisfeldt and Papanikolaou, 2013, 2014; Belo, Lin, and Vitorino, 2014), or both (Falato, Kadyrzhanova, and Sim, 2013; Peters and Taylor, 2017).

Capitalizing in this way requires assumptions about the capital accumulation process, such as intangible depreciation rates and the fraction of SG&A to be capitalized. Unfortunately, as Corrado, Hulten, and Sichel (2009) highlight, "relatively little is known about depreciation rates for intangibles" (pp 674). While there remains no consensus, the most commonly used rates for knowledge capital originate from Li and Hall (2016) who use BEA data,[4] while Hulten and Hao (2008) provide the main parameter for organizational capital (hereafter, "BEA-HH"). These measures of depreciation rates, however, are limited by gaps in industry coverage or rely on modeling assumptions due to the lack of market prices.[5]

In this paper, we propose a capitalization model for intangible investment that incorporates market prices of intangible assets to produce a new set of intangible capitalization parameters. We use these parameters to calculate values of off-balance sheet intangible capital and add them to existing book values of invested capital. The results are more accurate capital stock measures for the Compustat universe of firms. Then, in a series of validation tests, we show that these estimates perform at least as well or better than existing parameter estimates (i.e., BEA-HH).

It is well-recognized (e.g., Griliches, 1996; Li and Hall, 2020) that a major impediment to

[4]This paper first circulated in 2010.

[5]Less than 15% of 4-digit SIC codes have depreciation rates for knowledge capital. Organizational capital parameters have only been estimated in the pharmaceutical industry.

estimating the parameters of the intangible capital accumulation process is that most firms conduct R&D and other intangible investment activities for use within the firm, i.e. a direct marketplace for intangible assets does not exist. While this means that we rarely observe a firm's intangible capital price, we explore settings where market prices for intangible assets are available. In turn, we develop a framework that takes advantage of these prices to estimate parameters of a capitalization model of past investment flows. Using intangible asset prices to develop these parameters is advantageous, as prices allow us to incorporate non-production benefits such as real option value while not having to take a stance on production functions or the lag structure of intangible investment benefits.

The first approach uses public equity prices and balance sheet information to infer the value of a firm's intangible assets. Using the universe of CRSP-Compustat public firms, we take the market enterprise value and subtract two different estimates of the market value of tangible assets. This approach to calculating intangible asset values requires that the market value of a firm's equity (plus debt and preferred stock) captures the value of both physical and intangible assets. Thus, once we have an estimate of the market value of tangible assets, intangible asset value follows. Although we can calculate this on all public firms, it demands we translate the physical book asset values on the balance sheet to market value. We consider two straightforward approaches in the estimation, labeling them Compustat-baseline and Compustat-adjusted.

We source the second set of prices from acquisitions. Acquisitions provide an excellent setting to price intangibles because the SEC and GAAP mandate the allocation of the purchase price paid for the target's net assets across tangible assets, liabilities, identifiable intangible assets (IIA), and goodwill (GW). Given that acquisitions mark tangible assets to market (i.e. stand-alone fair value) in the purchase price allocation, the sum of IIA and GW represents the total price paid for intangible capital in an acquisition. One can view the sum of IIA and GW as the residual after the auditor assigns market values of net tangible assets, which is likely an easier task. Thus, unbiased estimates of total intangible assets follow from unbiased market values of net tangible assets. Our acquisition sample spans the years 1996–2017 and comprises a substantial fraction of

U.S. publicly traded acquirer-target pairs found in SDC's M&A database. As an alternative sample of acquired assets, we consider an alternative set of prices that add assets acquired in bankruptcy to the baseline acquisition sample.

We use the four sets of prices to estimate the capitalization model. The estimates vary across the choice of prices and adjustments, but two patterns emerge. First, the parameter that captures the fraction of SG&A expenditures that is investment varies across industry. This variation is in sharp contrast to the assumed single value for the parameter used in the literature. Second, while the R&D depreciation parameter estimate is close to the current benchmark BEA-HH across all industries, most of the alternative price choice exhibits higher depreciation rates in the two industries with the most R&D spending: healthcare and information technology. While these differences suggest that our approach may have discovered additional features of intangible investment, they also demand that we systematically compare the implied intangible capital stocks in out-of-sample settings.

Parameter estimates in hand, we propose a series of diagnostics to compare the alternative intangible asset estimates to the BEA-HH benchmark. The primary validation test asks whether incorporating intangible capital estimates improves the explanatory power of market enterprise values with book capital stock values. We compare the market enterprise value explained by book values augmented with our price-based intangible capital estimates with that which can be explained by book values augmented with intangible capital estimates using BEA-HH parameters. The Compustat-adjusted method that uses gross values to approximate physical asset markup and the Acquisitions-adjusted estimates each improve the R^2. The latter improves the R^2 in the cross-section in all years from 1986 to 2016, while this additional power is statistically significant in all years after 1995. We take these two of the original four intangible price alternatives to the remaining diagnostic tests to determine which provides the best estimate of intangible capital.

The next two tests verify whether our estimates of organizational capital are better at capturing differences in human capital and brand value versus BEA-HH estimates of organizational capital. We follow Eisfeldt and Papanikolaou (2013) in examining whether firms with high organizational capital are more likely to disclose risks regarding the potential loss of key talent in their 10-K filings. To do so, we analyze text from management discussions about risk in over one hundred thousand 10-K filings from 2002–2017 and identify whether the firm mentions "personnel" or "key talent." The acquisitions-based measure of organizational capital stock outperforms both BEA-HH and the Compustat-adjusted stocks in all years: firms in the top quintile of organizational capital stock are significantly more likely to mention these human capital risks than those in the bottom quintile. A similar exercise using firms' brand (Interbrand) and employee satisfaction ranking (Edmans, 2011) also show that the Acquisition-adjusted organizational capital estimates are superior.

Next, we test whether including the two alternative total estimated intangible capital stocks in book equity affects the portfolio returns from the HML factor of Fama and French (1992, 1993). Both the Compustat- and Acquisition-adjusted stocks increase returns and lower standard deviations. The acquisition prices approach has a bigger impact: the value premium (HML) exhibits returns that are 54% larger and a have smaller standard deviation than when constructed using book equity alone, leading to an 87% increase in the Sharpe ratio. The final validation asks if and how our the new estimates of intangible capital can explain previously established measures of patent values and trademark production. We find that the Acquisitions-adjusted stocks explain relatively more of the cross-sectional variation in patent valuations from Kogan, Papanikolaou, Seru, and Stoffman (2017) and the number of new trademarks filed by a firm in a given year (Heath and Mace, 2020).

From assumptions about physical markup, sample selection and price adjustments, each of our proposed methods have strengths and weaknesses. The collection of diagnostic tests lead us to select the intangible asset estimates derived from the adjusted acquisition prices as the preferred method. Although the results suggest that incorporating these new intangible stocks will improve the empirical performance in a wide variety of finance and accounting research settings, the flexible estimation framework allows future researchers to improve upon the model's data input and thus provide superior parameter estimates.

We contribute to three broad literatures. First, we provide parameter estimates to corporate finance researchers that rely on estimates of intangible capital as an input to examine real outcomes in firms (Eisfeldt and Papanikolaou, 2013; Gourio and Rudanko, 2014; Sun and Zhang, 2018). Second, we contribute to a long-standing literature on growth economics that attempts to measure the value of knowledge in the economy. Specifically, our work both re-estimates the knowledge capital accumulation process using market prices and extends these estimates to organizational capital for the first time (Corrado, Hulten, and Sichel, 2009; Corrado and Hulten, 2010; Acemoglu, Akcigit, Alp, Bloom, and Kerr, 2013; Hall, Mairesse, and Mohnen, 2010). Finally, we contribute to an active debate surrounding off-balance sheet intangible capital. Lev (2018) suggests that standard-setters' resistance to recognizing intangibles on firm balance sheets has substantial costs to both firms and the broader economy. In addition to confirming the value-relevance of currently included intangible assets such as goodwill, we provide evidence that estimating the value of internally generated intangible capital is feasible and provides meaningful information to financial statement users.

1 A Framework for Estimating Intangible Capital

Generally Accepted Accounting Principles (GAAP) rules rarely allow firms to capitalize intangible capital on the balance sheet. Researchers have responded to this lack of disclosure by constructing estimates for the stock of intangible capital using the perpetual inventory method, which aggregates net investment flows over the life of the firm.[6] This is done by adding the beginning value of the intangible capital stock to any periodic intangible investment flows and subtracting any depreciation as shown below in (1), for capital stock K at the end of year t:

$$K_t = K_{t-1} + Z_t - D_t \tag{1}$$

[6] e.g., Cockburn and Griliches (1988); Eisfeldt and Papanikolaou (2013, 2014); Hall, Mairesse, and Mohnen (2010); Hulten and Hao (2008)

where Z_t represents periodic investment, and D_t represents depreciation during period t of existing stock K_{t-1}. Assuming that K depreciates geometrically at the rate of δ, we have:

$$K_t = K_{t-1}(1-\delta) + Z_t \tag{2}$$

Through iterative substitution, the intangible capital stock becomes the total sum of all undepreciated intangible investments throughout the firm's existence.

$$K_t = \sum_{i=0}^{\infty}(1-\delta)^i K_{t-i} \tag{3}$$

Thus, to measure a firm's stock of intangible capital via (3), we need the depreciation rate, δ, and a mapping from accounting statements to periodic measures of investment, Z.[7]

The literature focuses on two distinct categories of intangibles: knowledge and organizational capital. Given that knowledge capital relates to information learned about processes, plans or designs that can lead to economic benefits in future periods, prior literature has used a firm's Research and Development (R&D) expenses as a proxy for its periodic investment in knowledge capital.[8]

The definition of organizational capital is more vague. Evenson and Westphal (1995) define organizational capital as knowledge used to combine human skills and physical capital into systems for producing and delivering want-satisfying products. Eisfeldt and Papanikolaou (2013, 2014) define organization capital as intangible capital that relies on essential human inputs, i.e. the firm's key employees. Lev and Radhakrishnan (2005) define organizational capital more broadly,

[7]Due to data limitations on intangible expenditures, e.g. unobservable accounting expenditures prior to the firm being publicly-traded, (3) is often modified as follows:

$$K_t = (1-\delta)^k K_{t-k} + \sum_{i=0}^{k}(1-\delta)^{k-i} Z_{t-i}$$

where K_{t-k} is an initial intangible capital stock.

[8]Consistent with this notion, ASC 730 defines research activities as development of "the translation of research findings or other knowledge into a plan or design for a new product or process."

as an agglomeration of technologies such as business practices, processes and designs that gives a firm a competitive advantage and enables it to extract additional economic rent from its operating activities.

Because of GAAP's broad definition of Selling, General, and Administrative Expenses (SG&A), which aggregate a variety of operating expenses unrelated to the cost of goods sold, researchers must decide which SG&A flows should be capitalized into organizational capital and which SG&A flows should be expensed. For example, employee training and advertising expenses should be capitalized and depreciated because their economic benefits extend past the contemporaneous period where the expenditure was made, while others such as rent expenses, legal fees and overtime wages clearly should not be capitalized since they represent payments for services rendered for a specific period of time. As a result, researchers often assume that a proportion of SG&A should be capitalized into organizational capital. As such, we define the fraction of total SG&A expense which represents an organizational capital investment as γ_S.

Thus, attempts to capitalize intangible investments requires values for the parameters governing the capital accumulation process. To the best of our knowledge, there is no comprehensive estimate of the depreciation rate of organizational capital. The only estimate of γ_S comes from Hulten and Hao (2008), who estimate it based on descriptions of income statement items from six pharmaceutical firms in 2006. Conversely, there have been a number of attempts to estimate the depreciation rate for R&D investments (δ_G). The main challenges in estimating δ_G, as stated by Griliches (1996) and Li and Hall (2020), stem from the fact that the majority of firms conduct R&D activities for use within the firm, and thus market prices do not exist for most R&D assets. Most models that estimate R&D depreciation therefore require strong assumptions about the channel through which knowledge capital affects firm behavior or outcomes.

Pakes and Schankerman (1984), for example, develop a model by which they infer δ_G by examining the decline in patent renewals over time. This assumes that valuable R&D must result in patents and that the value of R&D is directly inferable from the patent renewal decision. Lev and

Sougiannis (1996) assume that amortization of knowledge capital enters the production function directly and estimates an amortization model by regressing firms' current period operating income on lagged values of R&D expenditures. Li and Hall (2020) also use a production function approach. Their model assumes a concave profit function for R&D investment and that the firm invests optimally in R&D capital to maximize the net present value of its investment. Unlike tangible assets, the model assumes that R&D capital depreciates solely because its contribution to the firm's profit declines over time. Their estimated parameters are based on NSF-BEA data and cover only 10.5% of 4-digit SIC codes and 28% of firm-year in Compustat, thus requiring other assumptions for firms in SIC codes outside of these estimations.

Our goal in this paper is to develop a panel set of firm-year intangible capital stocks that most accurately represents the undisclosed economic assets that are expected to yield future benefits to the firm. In order to do this, we need estimates of the key parameters, i.e. δ_G, γ_S, that have minimal bias and noise. Prior approaches to estimate these accumulations of intangible capital have estimation issues due either to assumptions embedded in the structural model or assumptions about the channel through which these investments produce value.[9] Many of these issues are detailed in Griliches (1996). To avoid many of these pitfalls in previous approaches, we rely on market prices, as detailed below.

1.1 Empirical Strategy

Using firm prices provides several benefits to our estimation process. Since firm prices represent the present discounted value of all future benefits to the firm, we can account for non-production benefits such as real option value. Our estimates do not rely on either a well-specified production process or any knowledge of the lag structure of benefits generated by intangible assets. Finally,

[9]For example, investigating the descriptions of income statements directly forces the researcher to make judgment call about what items represent an investment into long-lived capital. Estimating the value of intangible assets via patent renewals or a production function assumes that a single channel is the only mechanism through which intangible assets can produce value, while in reality intangible investments may benefit the firm's cost of equity or provide strategic real option value. The production function approach also necessitates taking a strong stance on the lag structure of benefits produced by intangible investments.

by simultaneously estimating the stock of knowledge and organizational capital, we can account for any potential complementarity between these assets.

We estimate an equation of the form

$$P_{it}^{I} = f(I_{it}, K_{it}^{int}(\theta_{it}); \xi_{it}) \tag{4}$$

where P_{it}^{I} is the market price of intangibles in the firm, I_{it} is the balance sheet value of externally acquired intangibles[10], K_{it}^{int} is the book value of internally generated intangible capital stock as a function of estimated parameters (θ_{it}) and $f(\,\cdot\,; \xi_{it})$ is the mapping from book values to market prices of intangibles.

The target's externally purchased intangibles, I_{it}, are disclosed on the asset side of its balance sheet (Compustat item *intan*). Building on the large empirical literature discussed in Section 1 above, we measure the value of internally generated intangible capital as the sum of knowledge and organizational capital,

$$K_{it}^{int} = G_{it} + S_{it}$$

where G_{it} is the value of knowledge capital, and S_{it} is the value of organizational capital for firm i in year t. We calculate these capital stocks by accumulating a fraction γ_S, γ_G of past spending in R&D and SG&A[11] using the perpetual inventory method:

$$G_{it} = (1 - \delta_G)G_{i,t-1} + \gamma_G R\&D_{it} \tag{5}$$

$$S_{it} = (1 - \delta_S)S_{i,t-1} + \gamma_S SG\&A_{it}. \tag{6}$$

Therefore, the fully specified capitalization model is:

$$K_{it}^{int} = (1 - \delta_G)G_{i,t-1} + \gamma_G R\&D_{it} + (1 - \delta_S)S_{i,t-1} + \gamma_S SG\&A_{it} \tag{7}$$

[10]Under GAAP regulations, firms are record to report intangibles acquired in mergers or acquisitions as either identifiable intangible assets or goodwill

[11]SG&A is measured net of R&D expense (*xrd*) and Research and Development in Process (*rdip*).

We assume that the function f in Equation (4) is linear and that the market-to-book enters as a multiplicative factor $\xi_{it} \in (0, \infty)$:

$$P_{it}^{I} = \xi_{it}(I_{it} + K_{it}^{int}) \tag{8}$$

Our ultimate goal is to estimate the structural parameters of the perpetual inventory Equation (7), $\theta = (\delta_G, \delta_S, \gamma_G, \gamma_S)$ and ξ_{it}, by comparing the stock of intangible capital to the market price of intangible capital P_{it}^{I}. Rearranging (8) shows that ξ_{it} is the intangible market-to-book ratio $\left(\xi = \frac{P}{I+K^{int}}\right)$.

1.2 Estimation details

Our objective of estimating the book value of intangibles $I_{it} + K^{int}$ requires an assumption about ξ_{it}. One option is to let $f(\,\cdot\,;\xi_{it})$ be the identity function, equivalent to setting $\xi_{it} = 1$. Theories of firm dynamic investment such as Hayashi (1982) predict that ξ_{it} is one *on average.*

To implement this in our framework we let ξ_{it} be a function of time through a modified year or industry-year fixed effect which is assumed to be one on average over time:[12]

$$\xi_{it} = \rho_{jt} \tag{9}$$

$$st. \sum_{t} \frac{\rho_{j=j',t}}{T} = 1 \;\forall j' \in j. \tag{10}$$

Alternative assumptions for the relationship between firm book and market values of intangible assets are easily accommodated in our setting by modifying the parameterization of ξ_{it}.

The estimation of (8) proceeds in several steps. First, to avoid weighting firms by size, and without an obvious scaling variable, we first take the natural logarithm of each side of Equation

[12] It is important in this case to average the year fixed effect over time, rather than across observations, because any imbalance in our sample panel may lead us to over- or under-weight certain time periods. This is especially a concern in our firm exit sample discussed in Section 3.2 below. Firm acquisitions and failures tend to cluster in economic booms and busts, respectively. In this setting, averaging the fixed effects across observations would cause the estimation to overweight these time periods in estimation of the fixed effects.

(8):

$$log(P^I_{it}) = log(\rho_t) + log(I_{it} + K^{int}_{it}) \tag{11}$$

Next, due to the nature of R&D and SG&A spending, in particular that they are very stable within firms over time, the parameters γ and δ in each capital accumulation process are not separately identifiable. To see this, using SG&A spending as an example, consider the perpetual inventory equation for a firm i:

$$S_{it} = \sum_k \gamma SG\&A_{i,t-k}(1-\delta_S)^k.$$

If $SG\&A_{it}$ is constant for firm i, $SG\&A_{it} = SG\&A$, we have

$$S_t = \sum_k \gamma SG\&A(1-\delta_S)^k = \gamma SG\&A \frac{1}{1-(1-\delta_S)} = \gamma SG\&A(\frac{1}{\delta_S}) = \frac{\gamma}{\delta_S} SG\&A$$

In this case we can only identify the ratio $\frac{\gamma}{\delta_S}$. A similar result holds if SG&A has a constant growth rate.

We address this issue by reducing the parameter space through calibration of a subset of parameters. In particular, for organizational capital, we estimate the parameter γ_S, taking the depreciation of organizational capital δ_S as the standard 20% from the literature. We explore the implications of this assumption in Section 6. Briefly, any change in the calibration of δ_S has an offsetting effect on the estimate of γ_S and has relatively small implications for the stock of organizational capital in any given firm-year. Given that the goal of our research is to build accurate and unbiased stocks of both organizational and knowledge capital, we are comforted by the aforementioned fact. For knowledge capital, we assume that $\gamma_G = 1$, as is standard in the literature, and estimate δ_G.[13]

[13] One should think about this calibration in the following way. R&D projects can be successful, generating knowledge capital, or failed, generating nothing. The parameter γ represents the fraction of projects that are successful. Since we do not observe project success, we assume all projects are successful ($\gamma_G = 1$) and the fraction of failures is subsumed by the estimate of δ_G. When R&D spending is constant, and only the quantity γ/δ is identified, this will manifest by increasing the estimate of δ relative to its true value by a factor of $(1/\gamma)$. While this assumption does not perfectly hold in reality, as with organizational capital above the implications for the stock of knowledge capital in any given firm-year are quite small.

Finally, since we hypothesize that the capital accumulation parameters likely vary significantly by industry, as demonstrated by, for example Li and Hall (2020), we allow the parameters to vary by industry. Substituting for the G and S in Equation (11), we estimate the structural parameters by minimizing the sum of squared errors of the non-linear equation:

$$log(P^I_{it}) = log(\rho_t) + log(I_{it} + \sum_{k=1}^{T}(1-\delta^j_G)^k \text{R\&D}_{i,t-k} + \sum_{k=1}^{T}(1-0.2)^k \gamma^j_S \text{SG\&A}_{i,t-k}) + \varepsilon_{it} \qquad (12)$$

Since the model is in logs, model fit is assessed by comparing the exponent of the root mean standard error generated by the model to the exponentiated root mean squared error of a model that contains only a constant in the estimation. Because the model does not contain a constant, a negative pseudo R^2 is possible. Last, we calculate standard errors by bootstrap, re-drawing price observations, and thus the full time-series of company investments, with replacement.[14]

1.3 Previous parameter estimates and assumptions

As discussed in Section 1 above, prior research has used numerous methods to measure δ_G, the R&D depreciation rate from Equation (5), and these methods have produced a variety of values due to differing assumptions and models. For instance, Pakes and Schankerman (1984) estimate δ_G = 0.25 from a sample of patent renewals from the 1930s while Lev and Sougiannis (1996) finds δ_G to vary between 0.11 and 0.20 across industries. Bernstein and Mamuneas (2006) estimate a δ_G of 18%. Li and Hall (2020) use BEA data and find δ_G between 0.12 and 0.38. As a result, researchers have used a range of assumptions for δ_G. For example, Corrado, Hulten, and Sichel (2009) assume δ on R&D investments is 0.2. Falato, Kadyrzhanova, and Sim (2013) assume δ on R&D equals 0.15. Peters and Taylor (2017) use the δ_G estimates from Li and Hall (2020) and use 15% when estimates are unavailable, an approach that has become common in recent years. To our knowledge, there have been no estimates of γ_G in the literature, with researchers generally assuming that $\gamma_G = 1$, a

[14]We run bootstraps with 1,000 replications, re-drawing across all events before weighting to match the unconditional relative frequency of event types.

convention we maintain.

Prior estimations of the parameters for organizational capital have been more sparse. The sole estimate of γ_S comes from Hulten and Hao (2008), who estimate γ_S from the income statements of 6 pharmaceutical firms, and there are no direct estimates of δ_S.[15] Accordingly, a variety of assumptions have been used for γ_S and δ_S. For example, Eisfeldt and Papanikolaou (2013) rank firms by organizational capital stock within industry assuming a δ_S of 0.15, based on the common assumption for δ_G. Eisfeldt and Papanikolaou (2014), Li, Qiu, and Shen (2018), and Peters and Taylor (2017) measure organizational capital by assuming γ_S is 0.3 and δ_S is 0.2, while Falato, Kadyrzhanova, and Sim (2013) assume both δ_S and γ_S on SG&A to be 0.20.

In summary, the lack of a consensus for γ_S, and δ_G has led to a wide range of parameters being used to capitalize internally generated intangibles, thus motivating us to examine whether market prices can allow us to create a better set of parameters which can serve as a consensus in future research. The most commonly used proxy assumes that knowledge capital depreciates according to the parameters estimated by Li and Hall (2020), when available, and 15% otherwise while using the estimate that 30% of SG&A represents an investment into organizational capital with a depreciation of 20% per year. Thus, this parameterization (which we will henceforth refer to as BEA-HH) will be used as a benchmark comparison in the series of validation tests which we present below.

2 Diagnostic Tests

As we are proposing a new estimation of parameters that underlie construction of intangible capital for which there are existing estimates, we now present a set of diagnostics to compare alternatives with two goals in mind. First, the intangible capital measure should proxy for future benefits the asset provides to its owner. Second, the stock measure should correlate with outcomes expected

[15] The depreciation rates of some sub-components, e.g. brand capital, exist. For example, Lambin (1976) reports that the depreciation rate estimates for advertising effects are on average around 50% per year across a series of products.

from the investment.

Suppose that we have estimates for δ and γ like those from in Section 1.3. Then for firm i, at time t, we construct book value of its knowledge, organizational, total intangible capital and total capital:

$$\hat{G}_{it} = g(RD, \hat{\delta}_G, \gamma_G) \tag{13}$$

$$\hat{S}_{it} = g(SGA, \delta_S, \hat{\gamma_S}) \tag{14}$$

$$\hat{K}^{int}_{it} = \hat{G}_{it} + \hat{S}_{it} \tag{15}$$

$$\hat{K}^{tot}_{it} = \hat{K}^{int}_{it} + K^{phy}_{it} + I_{it} \tag{16}$$

where we sum over past R&D and SG&A spending from $t-10$ to time t.[16]

The diagnostics will separately evaluate knowledge capital ($\hat{G}$) and organizational capital ($\hat{S}$), along with total invested capital that reflects off-balance sheet capitalized intangibles as well as capital reported to the balance sheet. Diagnostic tests are one of two types. The first sorts firm-years by the magnitude of the capitalized intangible component into separate groups (from high to low) and asks whether these resorted groups result in larger differences of expected outputs for each type of intangible investment. Such a method is popular in the construction of asset pricing factors. The second diagnostic type is a simple test of fit where we ask whether including the estimated intangible capital improves the explanatory power in a regression. Regressions will include dependent variables connected to value or output.

2.1 Explaining market valuations

The first diagnostic examines the change in the informativeness of book values of invested capital in explaining market enterprise values when book values are augmented with capitalized intangibles. Connections between a firm's book value of capital stock and market valuations play important

[16] This ten year window constraint simplifies the data construction and has little impact on results.

roles in the investment-q and asset pricing literature. The intuition is straightforward. Book values, when properly measured, reflect the firm's capital investments that are available to produce future cash flows. Market values reflect investor expectations of these discounted future cash flows. To the extent that intangible capital stocks have been properly measured, augmenting these values to book values of intangible capital will reduce measurement error, and thus improve the fit between a regression of market enterprise value on book invested capital. We use a simple regression of firm enterprise value on measures of capital stock to evaluate the new intangible asset estimates:

$$\log(E_{it}) = \alpha + \beta \log(K_{it}^{tot}) + \varepsilon_{it} \tag{17}$$

where E_{it} firm i's year t enterprise value (i.e. the sum of end of fiscal year market capitalization, total debt and preferred stock) and K_{it}^{tot} is the book value of the capital stock (Compustat *at* if unadjusted). We estimate (17) in the cross section by year. If intangibles are capitalized as proposed, then the asset side of the balance sheet should be adjusted, improving the explanatory power of these regression. Here we simply replace K_{it}^{tot} with the alternative intangible stocks $K_{it}^{phy} + K_{it}^{int}$ where K_{it}^{int} is the sum of externally acquired and internally generated intangibles. We expect the most precise measures of intangible capital to have augmented book values that are most reflective of market enterprise values. Since the explanatory power of the baseline regression is quite high, our diagnostic compares the additional explanatory power of each alternative over the standard BEA-HH measure of K_{it}^{int}. Let RSS^{BEA-HH} be the residual sum of squares from the BEA-HH approach. The diagnostic reports the annual ratio $\frac{RSS^{BEA-HH} - RSS^{Alt}}{RSS^{BEA-HH}}$ where RSS^{Alt} is the residual sum of squares from each of the four proposed intangible asset price samples. A value greater than zero indicates improved fit, while we will select the approaches with the larger ratios.

2.2 Organizational capital

Lev and Radhakrishnan (2005) describe organizational capital as "an agglomeration of technologies – business practices, processes and designs, and incentive and compensation systems – that together enable some firms to consistently and efficiently extract from a given level of physical and human resources a higher value of product". We employ three tests for the measure of organizational capital $\hat{S}$, human capital risk, employee satisfaction and brand quality.

2.2.1 Human capital risk

Eisfeldt and Papanikolaou (2013) propose a model whereby organizational capital is a firm-specific investment which has outputs measured by a firm's key talent. Their model shows that the outside option of the firm's key talent determines the share of the firm's cash flows that accrue to shareholders, and thus shareholders bear more risk for firms with higher levels of organizational capital. They estimate the stock of organizational capital by capitalizing a firm's SG&A expenses, and validate their measure by examining the MD&A of firms with higher (lower) levels of organizational capital, and showing that firms with higher (lower) levels are more (less) likely to disclose the potential for key personnel loss as a significant risk factor to the firm. To do so, they seek out references for personnel risk in 10-K filings and argue that any firm sorting by a measure of organizational capital should correlate with such mentions. We follow a similar approach, using over 120,000 10-K filings from 2002–2016.[17] We calculate the fraction of words in the MD&A statement that reference risk of personnel loss (keywords: "personnel" or "talented employee" or "key talent").

We partition firms into quintiles based on their organizational capital stock scaled by assets in each year using each measure and then calculate the frequencies of mentions between the high and low partitions for each year. Because a more exact measure of organizational capital will more precisely sort firms into highest (lowest) quintiles of human capital risk, we expect that a more exact measure of organizational capital will have more (less) frequent mentions of personnel loss as a risk factor in the firm's MD&A. This diagnostic compares the relative performance of a set of organizational capital estimates $\hat{S}$.

[17] See `https://github.com/apodobytko/10K-MDA-Section` for the code to run this search.

2.2.2 Brand quality

As discussed in Section 1, organizational capital captures assets related to human capital, brand and company culture, among many others. Our next diagnostics asks whether our organizational capital stocks (and total intangible capital) exhibit stronger correlations with firm brand quality. To do so, we collect the top 100 global brands according to Interbrand, a brand consultancy, from 2000 to 2018.[18] We extract the ranking and merge each company (or brand) to U.S. public firms in Compustat.[19] This diagnostic is a simple fit test where we regress the log of a firm's brand rank on the log of organizational capital. The loading on the capital control should load negatively (i.e., higher stock, higher ranking) and a measure of intangible capital out-performs if it has a higher R^2 than the alternatives. The limited sample size restricts this diagnostic to a pooled OLS regression.

2.2.3 Employee satisfaction

The next diagnostic considers the relationship between a proposed measure $\hat{S}$ and a proxy for employee satisfaction. We use employee satisfaction data ("Best Companies to Work For") from Edmans (2011) and additional rankings from the online firm Glassdoor. The latter reports the "Best Places to Work"[20] using reviews posted by current employees. The Glassdoor rankings extend the Edmans (2011) sample for 2012 to 2018. We merge the annual rankings to Compustat and correlate these firms' estimated organizational capital stock with their ranking. The resulting dataset has 910 firm-year observations, which limits a diagnostic using annual regressions. We thus consider two alternative diagnostics. The first is a pooled regression of log employee satisfaction rank on the log of the organizational capital rank within sample. The second diagnostic reports the pairwise correlates of the level rank and tests their significance. We expect that firms sorted by organizational capital $\hat{S}$ should similarly sort by employee satisfaction. A measure outperforms

[18] See `https://www.interbrand.com/best-brands/best-global-brands/previous-years/2000/` for the raw data.

[19] If two brands from the same firm are on the list, we take the average rank within-firm.

[20] For example, see their 2019 ranking here `https://www.glassdoor.com/Award/Best-Places-to-Work-LST_KQ0,19.htm`.

another if the R^2 in the regression or correlation between the $\hat{S}$ sort and employee satisfaction is relatively higher.

2.3 Total intangible capital

The final three diagnostics evaluate output associated with investments in both knowledge and organizational capital.

2.3.1 Patent valuations

The most common output associated with knowledge capital is a patent (e.g., Hall, Jaffe, and Trajtenberg, 2005). The next test of an estimate of total intangible capital correlates it with the firm's patent counts and measures of patent quality. To do so, we use the patent valuations from Kogan, Papanikolaou, Seru, and Stoffman (2017). Let the patent valuation for firm i in year t be Patent_{it} (set to zero if missing). The regressions will take the following form:

$$\log(\text{Patent}_{it}) = \beta_0 + \beta_1 X_{it} + \beta_2 \log(\hat{G}_{it} + \hat{S}_{it} + I_{it}) + \nu_{it} \tag{18}$$

where X_{it} includes a control for a firm's lagged patent stock. This diagnostic will incorporate alternative measures of $\hat{G}_{it}$ and $\hat{S}_{it}$. We expect β_2 to be positive, while an approaches intangible capital measure out-performs when it has a relatively higher R^2 from (18). The diagnostic will compare the ratio of R^2 where the benchmark is the R^2 using estimated intangible capital from the BEA-HH method.

2.3.2 Trademarks

If a firm has a valuable brand, then it is likely to seek trademark protection. Such an intangible asset is likely connected to investment in both knowledge and organizational capital. We therefore consider a diagnostic based on trademark applications. Using code and data provided by Heath and Mace (2020), the diagnostic mirrors that in Section 2.3.1 for patents. We regress the count of new trademarks on total intangible capital.[21] The regressions takes the following form:

$$\log(\text{Trademark}_{it}) = \beta_0 + \beta_1 \log(X_{it-1}) + \beta_2 \log(\hat{G}_{it} + \hat{S}_{it} + I_{it-1}) + e_{it} \quad (19)$$

where Trademark_{it} is one plus the number of new trademarks in year t and X_{it-1} is the log of the previous year's active trademarks. The regressions is run on an annual basis. This diagnostic incorporates alternative measures of $\hat{G}_{it}$ and $\hat{S}_{it}$. We expect β_2 to be positive, while an total intangible capital measure out-performs when it has a relatively higher R^2 from (19) (relative to the BEA-HH benchmark).

2.3.3 The Value Factor

The final diagnostic examines the implications of augmenting book values with intangible capital in asset pricing tests as in Park (2019). Our analysis focuses on realized returns to the HML portfolio, a key input in the multi-factor Fama-French model (e.g., Fama and French, 1992, 1993). Constructed as a portfolio that is long (short) high (low) book equity to market equity firms, it has been well-documented that the HML portfolio earns positive expected returns. Mis-measurement of intangible capital will result in noisy measures of book equity values, resulting in an HML portfolio that is constructed with error due to incorrect firm sorts. We expect that augmenting book equity with more accurate measures of intangible capital will reduce these errors, thereby increasing the observed return and Sharpe ratio of the HML portfolio. Thus, the diagnostic for the value factor will compare each estimates' mean monthly return, Sharpe ratio and return predictability.

[21] The data are available in the Internet Appendix of Heath and Mace (2020).

3 Intangible asset price data

Our goal is to estimate Equation (12), and therefore the resulting capital stocks G_{it} and S_{it} produced by a firm's prior flows in R&D and SG&A. Data for the independent variables in (12) are simply the firm's reported value of externally acquired intangibles, R&D and SG&A (less R&D and In-Process Research and Development). All variables are available from Compustat. We use ten years of prior flows relative to the date that the price is observed, back-filling where needed.[22] The dependent variable, P^I_{it}, in (12) requires significantly more consideration.

In using P^I_{it} to estimate δ and γ, the sample of market prices should have minimal measurement error and be representative of the universe of firms for which we will estimate G_{it} and S_{it}. We rely on two sources of market prices: (1) a panel of Compustat firms, and (2) a sample of firms whose intangible assets are valued by the market in acquisition. Given that each has a distinct set of advantages and disadvantages, we rely on the diagnostic tests described in Section 2 to compare relative performance. Below, we detail the two sources of P^I_{it}, discuss the strengths and weaknesses of each sample, and detail any adjustments we make to the data to improve the quality of our estimates.

3.1 Intangible Market Valuations from Publicly Traded Equity

The first sample relies on market prices of publicly traded equity and arrives at P^I_{it} as the remainder value after adding the values of other forms of financing and then deducting the market value of tangible assets. The basic intuition is that publicly-traded equity reflects the value of physical plus intangible assets, thus with an estimate of physical asset value we can solve for intangible asset values. The chief advantage of this approach is its use of a representative sample. This benefit contrasts with the requirement that we make an assumption about the market value of tangible assets.

[22] Details of the back-filling procedure follow Peters and Taylor (2017) and rely on estimated real R&D and SG&A growth rates by firm age relative to the IPO year. See their Appendix B2 for details.

We use two approaches to arrive at the market value of intangibles and allow the tests of our estimated stocks to validate the preferred Compustat approach. In both approaches, we begin with the assumption that:

$$P_{it}^{Total} = P_{it}^{Tangible} + P_{it}^{I} \tag{20}$$

where P_{it}^{Total} is the market value of total assets and equals the sum of tangible plus intangible assets. Decomposing total assets into its financing components, we have:

$$P_{it}^{Total} = P_{it}^{Equity} + P_{it}^{Liabilities} + P_{it}^{Preferred} \tag{21}$$

Taken together, we solve for the market value of the firm's intangibles as the remainder value of the firm's total financing value less tangible asset value:

$$P_{it}^{I} = P_{it}^{Equity} + P_{it}^{Liabilities} + P_{it}^{Preferred} - P_{it}^{Tangible} \tag{22}$$

For publicly traded firms, we can observe market values of equity, but only book values of liabilities, preferred stock, and total assets. We follow prior literature and assume that market values of preferred stock and debt are well-approximated by their book values and we explore two different proxies for the book value of assets.

Our first approach ("Compustat-baseline") mirrors Hall (2001) and Gutiérrez and Philippon (2017) in assuming that physical asset markup is zero and sets the market value of tangible assets equals to their net Property, Plant and Equipment (PPE). This assumption could create estimation errors due to, e.g., rising costs over time. In this case, these errors would impart an upward bias to the imputed remainder value, P_{it}^{I}, ultimately resulting in biased measures of δ and γ and the resulting estimates of G_{it} and S_{it}.

The second Compustat-based approach ("Compustat-adjusted") mirrors Erickson and Whited (2006, 2012), and Peters and Taylor (2017) who uses gross PPE to proxy for the value of tangible assets. To implement this, we simply take reported total assets, subtract net PPE and add back gross PPE. Any markup choice is noisy, so we discuss the robustness of the results to an alternative markup procedure following (Erickson and Whited, 2006) that uses the compounded rate of inflation on net PPE. While we believe that the adjusted approach improves on simply using book values, we are aware that any remaining measurement error will still be reflected in P^I_{it}, and ultimately impact our estimates of G_{it} and S_{it}. A performance comparison in a subset of the diagnostics proposed in Section 2 will dictate the selected method.

Estimation includes all firms in the CRSP-Compustat merge outside of financial services, resources, real estate or utility SIC code. To avoid overlapping time series from a full Compustat estimation (excluding our acquirer-target deal-years), we randomly sample each firm once over its lifetime (after three years of trading) for 1986–2017.[23]

3.2 Intangible Market Valuations from Acquisitions

The second sample uses the market valuation of a firm's intangibles observed in acquisitions. Relative to the approach in 3.1, this setting has the advantage of providing a value of intangibles – P^I_{it} –, thus avoiding the markup assumption to net tangible assets. This is because accounting regulations (ASC 350) require that externally acquired intangibles are directly valued and recorded at market value on the acquirer's balance sheet as either identifiable intangible assets (IIA) or goodwill (GW). In addition, these intangible asset valuations measured during an acquisition event undergo an extensive due diligence process by expert appraisers that increases the precision of these appraisals.[24]

Data on acquisitions comes from Thomson's SDC Merger & Acquisition database. Sample construction starts with all U.S. public acquirer and public targets for deals that closed between 1996 and 2017 with a reported deal size. Our sample begins in 1996 because we require financial statements from the SEC's EDGAR website. We drop deals where the acquirer or target has a

[23]For robustness, we later repeat this exercise with several random samples, and find similar results.

[24]For instance, Wangerin (2019) finds that a strong due diligence process predicts a stronger connection between fair market valuations of in-process R&D and goodwill with post-acquisition equity market values.

financial services, resources, real estate or utility SIC code.[25] We also exclude all deals that use the pooling method pre-2001.[26]

We also require data on the acquirer's purchase price allocation of the target's assets in order to collect the prices paid for goodwill and identifiable intangible assets (IIA). When available, these purchase price allocations were found in the acquirer's subsequent 10-K, 10-Q, 8-K or S-4 filing. We found information on the purchase price allocation for 81% (1,719) of all candidate acquisitions.[27] In the final step, we merge the target and acquirer firms to Compustat and CRSP.

While goodwill should capture the target's unidentifiable intangible assets, prior studies have shown that goodwill payments in acquisitions may also represent overpayments due to agency frictions or hubris (e.g., Roll, 1986) as well as pair-wise synergies between the target and acquirer. We follow the Bhagat, Dong, Hirshleifer, and Noah (2005) framework for estimation merger value creation as an adjustment to goodwill. Specifically, using this probability scaling method for announcement day returns, we estimate the synergy and over-payment component of the acquisition value and then remove this estimate from goodwill valuations in the purchase price allocation.[28]

Our main concern regarding the acquisition sample of intangible valuations stems from the fact that acquisitions are not made randomly.[29] The adjusted acquisition approach ("Acquisitions-adjusted") attempts to address these selection concerns by augmenting the first sampling method with another set of target firm exit prices: failures. We add to the sample a panel of CRSP firm delistings from 1996–2017, arising from liquidations and bankruptcies.[30] Given the absence of purchase price allocations for these events, we estimate P_{it}^{I} as the percentage of assets recovered

[25]The excluded SICs are 6000 to 6399, 6700 to 6799, 4900 to 4999, 1000 to 1499.

[26]The results presented below for all deals from 1996–2017 are robust to exclusion of all pre-2002 deals.

[27]Some filings lacked the footnote for the acquisition (e.g., the acquisition was immaterial) or we could not identify any filing for the acquiring firm (e.g., the firm has a unique registration type with the SEC).

[28]In cases where the adjustment exceeds goodwill (less than 15% of deals), the remainder is removed from the IIA valuation. Additionally, we add one to both sides to avoid dropping observations with an implied price of intangibles of zero. Additional details on construction of acquisition prices is provided in the Appendix.

[29]Prior studies have linked acquisitions to the quality of both the acquirer and the target firm (e.g., Maksimovic and Phillips, 2001) and the innovation needs of the acquirer (e.g., Phillips and Zhdanov, 2013; Bena and Li, 2014), and the fact that acquisitions can be predicted by the relative market-to-books of acquirers and potential targets (e.g., Rhodes-Kropf, Robinson, and Viswanathan, 2005).

[30]CRSP delisting codes of 2 and 3.

during the bankruptcy event[31] from Moody's Default and Recovery Database[32] multiplied by the ratio of IIA and goodwill to total deal size for the same 4-digit SIC code in the baseline sample.[33] For both samples, we again estimate γ_S and δ_G using Compustat *intan* as a proxy for the firm's externally acquired intangibles, and ten years of past R&D and SG&A spending.[34]

In our attempt to address acquisition sample selection issues with failures, we know that firms do not exit the sample through failure randomly, and thus our adjusted sample is still not randomly selected. Ultimately, each of these methods have downsides in terms of sample choices and pricing assumptions. Thus, we will rely on the results of the diagnostic tests detailed in Section 2 to compare the baseline versus adjusted methods here, and how they perform relative to the stock estimates derived from Compustat prices.

4 Estimating the capital accumulation process

Table 1 reports the imputed estimates for Equation (12) in the previously mentioned samples in Section 3. As previously detailed, we run each of the four panels (Compustat-baseline, Compustat-adjusted, Acquisition-baseline, Acquisition-adjusted) and estimate the main parameters γ_S and δ_G for each. The report parameters reflect a specific γ_S and δ_G for each of the Fama-French 5 industry classifications over the full time-series, as well as a set of parameters that are estimated across the entire panel. In all of the estimations, we assume that δ_S and γ_G are equal to 0.2 and 1.0, respectively.

[31] Ma, Tong, and Wang (2019) show that assuming a value of zero for intangibles is incorrect because innovation is a crucial asset class in asset allocation in bankruptcy.

[32] This file covers fully resolved large public U.S. corporate defaults between 1987 and 2019, and includes the final recovery of total debt, based on 10-K, 10-Q, press releases, and other legal filings. The data field named "FAMILY_RECOVERY" provides the dollar-weighted proportion of debt recovered after discounting for lost interest. We find exact matches with our sample of CRSP delistings for 95 of 478 events. We use industry (Fama-French five industries) average recovery rates from the same database for the remaining firms (49% across all firms). This recovery rate multiplied by outstanding debt forms our "deal value" for this sample of exit firms.

[33] All results below are robust to setting the fraction to one-half or one-quarter of the acquisition sample fraction. The Appendix provides additional details on the construction of failure prices.

[34] We set the relative regression weighting of acquisitions and failed firms in our sample such that the weighted fraction of acquisitions and failures match the unconditional relative frequency of acquisitions or buyouts and non-acquisition de-listings found in Compustat-CRSP.

Columns (1) and (2) report BEA-HH parameters for comparison with our market pricing parameters. Recalling that δ_G represents the depreciation rate of R&D capital, and γ_S represents the proportion of SG&A that is to be classified as a long-lived asset, it follows from Equation (12) that higher (lower) values of δ_G (γ_S) will lead to higher levels of G_{it} (S_{it}). For example, examining the "All" row in Table 1, we can compare the values of Compustat-Baseline to BEA-HH and conclude that the capitalized intangible stocks using Compustat-Baseline parameters will be larger than capitalized intangible stocks using BEA-HH parameters, because γ_S is significantly larger (0.59 vs. 0.3), which will result in a higher level of organizational capital and δ_G is significantly smaller (0.23 vs 0.28), which will result in a higher level of knowledge capital. Conversely, the Acquisition-adjusted sample will have smaller capitalized stocks relative to the BEA-HH stocks because its parameter estimates of γ_S is 10% smaller (0.27 vs 0.3) and δ_G is 18% larger (0.33 vs 0.28).

Comparing the different versions within each data source, we can similarly conclude that the Compustat-Baseline "All" parameters will cause larger values of capitalized intangibles than those of the Compustat-Adjusted sample, because the Compustat-Baseline parameters have larger (smaller) γ_S (δ_G) values. Recall from Section 3.1 that the Compustat-Baseline sample assumes no markup to the book value of net tangible assets . It is likely that this lack of markup results in high (low) values for γ_S (δ_G), since a downward bias to $P_{it}^{Tangible}$ will impart an upward bias to P_{it}^{I}, resulting in biased estimates of γ_S (δ_G). If this is the case, the measurement error will manifest itself as lower performance in the validation tests. Similarly, we can compare the parameters of the Acquisition-Baseline with the Acquisition-Adjusted sample, and conclude that capitalized intangible stocks will be smaller in the latter. This is consistent with the logic that the Acquisition-Adjusted sample, which includes exit prices owing to liquidation and bankruptcy, are likely to have lower valuations of organizational capital and more failed R&D projects, reducing the γ_S estimate and increasing δ_G. If the addition of exit prices from bankruptcy are effective in addressing potential selection concerns in the Acquisition-Baseline sample, we expect this to manifest itself with improved performance in the validation tests.

5 Validation of parameter estimation

We next apply parameter estimates from our base specification in Table 1 to the intangible capital accumulation process (Equation 7) to the broader CRSP-Compustat universe of firms.[35] The knowledge capital stock accumulates R&D spending following (5), while the organizational capital stock represents the accumulation of SG&A following (6). Both sets of intangible capital stocks use our industry-level estimates of γ and δ_G. Total intangible stock is the sum of knowledge capital, organizational capital and externally acquired intangibles on the balance sheet I_{it} (Compustat *intan*). The goal of this section is to determine which of the methods performs best in the diagnostics detailed in Section 2. We proceed in two steps. First, we select among the baseline versus adjusted approaches for both the Compustat and acquisitions method separately using the market value regressions (Section 2.1). Once we determine the best approach within each approach type, we run through the remaining diagnostics. Note that in untabulated results, we can skip the first test and run all four alternatives against the BEA-HH benchmarks. The ranking of measures is the same in the end, so for brevity's sake we consider the subset of each approach.

5.1 First selection step using firm valuations

Our first goal is to select the best among the two approaches: Compustat and acquisitions. The resulting "winners" from each approach can then be compared using the battery of diagnostics described in Section 2. We will use the main public firm valuation test detailed in Section 2.1 for the initial selection criterion. Recall that we regress a firm's enterprise value on the estimated total capital stock – including intangibles – from each of the four methods. The benchmark is the residual sum of squares from estimation of Equation (17). Running this regression for the full 1986–2016 Compustat sample results in a R^2 of 84.4% when we include none of the intangible capital

[35] We follow Peters and Taylor (2017) in the details of the capital accumulation process such as capital stock initialization. For details see Appendix B2 of their paper.

measures.[36] Figure 2 presents the results. Consider first the time series for the "Compustat" and "Acquisitions" data. For each, the estimated intangible stocks provide relatively *worse* explanatory power of market enterprise values than the current BEA-HH approach (between 0 and -15%). Next, we see that both the adjusted methods provide more explanatory power over some parts the sample period.

Figure 3 presents the formal test statistic for the null hypothesis that the R^2 from each method differs from that of BEA-HH.[37] The dashed orange line shows that only the Acquisitions-adjusted method produced statistically significant improvements in the R^2 since 1994 when compared to the baseline. Although the t-statistics for the Compustat-adjusted method are less than 2 in all buy two years, they are larger than all those from the unadjusted method. From these two figures, we rule out using these two non-adjusted methods and instead continue the remaining diagnostics with the Compustat-adjusted and adjusted acquisitions approach. Although the latter dominates across all years, we will evaluate each using the full set of diagnostics.

5.2 Organizational capital and personnel risk

Figure 4 presents the results of the diagnostic test for human capital risk detailed in Section 2.2.1. Recall that for each year and each intangible capital measure $\hat{S}_t$ we compute the t-statistic from the difference in means tests for the top versus bottom quintile of firms for the fraction of words that mention personnel risk. Across all years using the Acquisition-adjusted method, the fraction with some reference of personnel risk in the top quintile versus the bottom is 66% and 52%, respectively . This compares to 58% vs. 52% for the quintiles sorted using $\gamma = 0.3$ method from the literature and 61% and 52% for the Compustat-adjusted approach. In all years of the sample period, the difference between top and bottom quintile is significant using adjusted acquisitions stocks ("Acq-adj."). The Compustat-adjusted method produces significant t-statistics in all but

[36] The regression considers the shorter sample period because the R&D data is imperfect for years prior to 1975 (e.g., Nix and Nix, 1992). Starting in 1986 ensures that we have stocks computed using post-FAS 2 passage R&D.

[37] We conduct inference on R^2 values using influence functions (Newey and McFadden (1994)). In a regression $y = \beta x + \varepsilon$, this approach takes into account the estimation error in β, $var(y)$, and $var(x)$.

two years, however, they are uniformly smaller than those from the acquisition method. These differences show that the latter's organizational capital stocks generate better sorts on this risk factor. Note that neither estimation used any non-financial information from 10-Ks, so this can be viewed as an out-of-sample test. Both methods out-perform the current literature estimates ("HH") where the differences is statistically significant in only six of fifteen years. We conclude that the adjusted acquisition measure of organizational capital stock provides more predictive power for firm's assessment of the risks to their human capital.[38]

5.3 Organizational capital as brand and employee satisfaction

Our next exercise asks whether the estimated organizational capital stocks exhibit stronger correlations with firm brand quality and employee satisfaction than existing measures (Section 2.2.2). Table 2 reports the pooled regression results. Two facts emerge in these results. Both new methods improve the explanatory power of organizational and knowledge capital (R^2 in columns (2),(3) and (5), (6)). Next, the Acquisitions-adjusted stocks exhibit both the largest loading and R^2 in all specifications.

Next, we explore the connection between organizational capital and employee satisfaction (Section 2.2.3). Panel A of Table 3 reports the pooled regression of log employee satisfaction rank or log organizational capital rank along with pairwise correlations. The Acquisitions-adjusted measure exhibits the highest (albeit quite low) R^2 and weakly positive loading. Panel B reports the pairwise correlates of intangible capital estimate rankings with employee satisfaction rank. Each alternative exhibits a statistically significant positive correlation (as predicted), with the Acquisition-adjusted estimates producing the largest. Overall, the brand and employee satisfaction analyses demonstrate that the Acquisitions-adjusted approach produces the strongest proxy for organizational capital among the three options.

[38]Reassuringly, sorting firms by our organizational capital stocks (by year) results in similar patterns of firm productivity, size and executive characteristics as found in Eisfeldt and Papanikolaou (2013) (see Internet Appendix Table IA1).

5.4 Asset pricing implications

Table 4 compares the summary statistics of the traditional HML pricing factor with those constructed by adjusting GAAP reported book equity values with two of our new intangible stocks (Compustat-adjusted and Acquisitions-adjusted) and those following the BEA-HH parameters. The table shows that HML returns adjusted for intangibles are universally larger in total magnitude, while exhibiting smaller standard deviations than the unadjusted HML portfolio. The unadjusted HML portfolio has an average (monthly) return of 0.28%, the BEA-HH adjusted portfolio has monthly returns of 0.38%, and the Compustat-adj. and Acquisitions-adj. portfolios have mean returns of 0.41 and 0.43%, respectively. Only the Acquisitions-adj. portfolio's return is significantly larger at conventional thresholds (column 3). Additionally, this portfolio has a Sharpe ratio of 0.6, 87% higher than the traditional HML portfolio's Sharpe ratio of 0.32.

Figure 7 shows the accumulated log returns of the four HML portfolios over time. The lowest (dashed blue) line represents the accumulated log return of the traditional HML factor and shows the lowest accumulated return over the sample period, with negative average returns over at least the past decade. The dot-dashed yellow line is the BEA-HH adjusted portfolio. The two solid lines are adjusted with our new measures of intangible assets. Here the relative out-performance of the new intangible capital-adjusted HML portfolios is clear, with both of our new measures outperforming the traditional and the BEA-HH adjusted HML factors. The acquisition-adjusted (thick solid blue line) outperforms the Compustat-adjusted factor only in the past two decades.

While the conclusive mechanism for why HML is associated with future returns is beyond the scope of our paper, at least two potential explanations appear consistent with our finding that intangible capital adjustments increase HML portfolio returns. The first explanation is that firms with larger proportions of intangible capital have greater distress risk (Korteweg, 2010) and the second is that the stock market under-reacts more to firms with higher levels of intangible capital (Edmans, 2011). Regardless of the exact mechanism, our intangible adjustments to book equity result in changes to construction of the HML portfolio, pushing firms with higher (lower) intangible firms into the long (short) side of the portfolio and thereby increase the return spreads to the HML factor.

5.5 Patent valuations

Figure 5 reports the diagnostics discussed in Section 2.3.1 for patent valuations. We run the log of patent valuation on each of the estimated intangible capital stocks, save the R^2 and scale it by the R^2 from the regression using the BEA-HH stocks. First, note that the estimated stocks from the Compustat-adjusted method produce *less* explanatory power than those current used in the literature in all but one year. It is important to simultaneously highlight that this difference is negative, but very small. The acquisitions-adjusted method, in contrast, improves explanatory power – again, weakly – in all but five of the sample years.

5.6 Trademarks

Table 6 reports R^2 ratio from a regression of number of trademarks (log) on the alternative organizational capital estimates scaled by the R^2 from the regression using the HH implied stocks.[39] The first feature of Figure 6 is the relative under-performance of the Compustat-adj. stocks: in all but one year do they provide more explanatory power than the HH stocks. It is important to note, however, that the explanatory power is very similar. Next, the Acquisition-adjusted stocks provide both more explanatory power than those from Compustat and outside of five years, more than the HH stocks. This diagnostic reveals that the Acquisitions-adjusted approach out-performs the alternative for trademark output.

5.7 Summarizing the diagnostic tests

Each diagnostic shows that the stocks measured using the Acquisitions-adjusted parameters produce the sharpest cross-sectional sorts and explain more variation in innovative output proxies. We

[39] When we pool all years, the regressions range from an R^2 of 50-53%

therefore consider it the ideal choice among all the options, including the BEA-HH now used in the literature. As discussed in Section 3, each method has its owns strengths and weaknesses. The issues of physical markup or selection are not to be downplayed, but rather weighed against the improved performance in this range of out-of-sample tests. We hope that future researchers can apply the general model in Section 1 with improved data.

6 Robustness

All the results above are insensitive to changes to the Acquisitions-adjusted method. Acquisitions completed pre-2001 represent a subset of deals that did not use the pooling of interest method and thus there was not universal purchase price allocation. The major results in columns (7) and (8) of Table 1 are similar and the ranking from the above diagnostics is unchanged. Next, some argue that firms missing R&D in Compustat should not be treated as zero (Koh and Reeb, 2015), or that R&D is strategically allocated to other expense accounts. We remove firms or targets with zero and missing R&D in all estimations. Both δ_G and γ_S increase slightly in all columns of Table 1 with no change in conclusions from the diagnostics. These overall changes to parameter estimates are consistent with the removal of firms who may be shifting R&D expenses into SG&A. Finally, inherent difficulties in separately identifying both the fraction of SG&A that is investment and the rate of depreciation (footnote 12) demanded that we assume that $\delta_S = 0.2$. In unreported results, we consider a range of $[.1, .3]$ for the δ_S and re-estimate Equation (12) for all samples. As we increase the δ_S from 0.1 to 0.3, the estimated γ increases in each sample estimation and again, the ranking from the diagnostics is unchanged. We conclude two things from this exercise: (1) that our assumed $\delta_S = .2$ is not driving any of our results, and (2) that the pair of (γ, δ_S) is the key assumption for measuring organization capital.

7 Descriptive analysis using Acquisitions-adjusted estimates

We now explore some descriptive analysis using estimated intangible capital from the Acquisitions-adjusted method.

7.1 Comparison to existing methods

Figure 8 presents the difference between our estimates ("Acq.-adj.") and the current methods ("Current"), scaled by the latter. All parameters are time-invariant, so time-series variation stems from changes in the relative use of R&D and SG&A. The differences in our estimated intangible capital stocks relative to those from the literature vary across industries. The "All" line in the figure shows that the new estimate is approximately 10% smaller across all firm-years. Our intangible capital stocks are smaller than commonly assumed in both the consumer and manufacturing industries.

In contrast, our intangible stocks are larger in all years for hi-tech firms and half the years for healthcare. In both cases, higher estimates of δ_G, which imply smaller knowledge capital stocks, are outweighed by larger implied organizational capital investments. Given the larger estimated depreciation of R&D for healthcare (34% vs. 17%), the relatively smaller stocks in healthcare in the 2000s reflect firms' shift from organizational capital to knowledge capital investments. Overall, we find economically meaningful differences in implied stocks compared to existing methods. Next, we validate whether the differences improve the informativeness of capital stock book values.

7.2 Intangible capital stocks by industry and time

The growing importance of disclosing capitalized intangibles to firms' balance sheets is based on the idea that such intangibles are becoming an increasingly important component of how today's firms create economic value. Figure 9a presents time series trends of intangible capital for the four industries. Each series plots intangible intensity, calculated as the average ratio of intangible capital K^{int} ($S_{it} + G_{it} + I_{it}$) to total assets, e.g., intangible and tangible assets (Compustat *ppegt*).

As expected, intangible intensities are lowest in consumer and manufacturing industries. Firms in these industries have experienced an increase in the role of intangibles in their total assets since only the late 1990s. In contrast, healthcare and high-tech firms have higher intangible intensities that have each grown continually since the 1970s. The patterns in Figure 9a conform to basic predictions about differences across industries and time and provide the first validation that our estimates measure real economic assets.

Figure 9b explores the relative importance of knowledge versus organizational capital by plotting the ratio of the former to total intangibles K^{int}. Healthcare has the highest intensity of knowledge capital (and thus the lowest organizational capital intensity). Both healthcare and high-tech firms experienced increases in knowledge capital stocks from 1977 – 1996. Since 1996, growth has either stalled (Healthcare) or the levels have fallen back to 1970's levels.[40]

7.3 Market-to-book ratios

Last, we re-examine the time series behavior of market-to-book ratios with these new capital stocks and compare them with the time series behavior of unadjusted market-to-book ratios. We calculate the average market equity value to book value from the period 1997–2017 for both sets of capital stocks, and run a simple linear regression of

$$\frac{M}{B}_t = \beta_0 + \beta_1 \text{Year}_t + \epsilon_t$$

Figure 10 reports two time-series plots with best-fit lines for the standard ratio and that adjusted using the Acquisition-adjusted stocks. Each series excludes the sample of acquirers and targets. Unadjusted (i.e. internal intangibles excluded from assets), the slope coefficient of 0.041 shows that, on average, the Market-to-Book ratio is drifting upwards by 0.041 per year. After our adjustments for intangible capital, we find the slope coefficient to be 0.012, a decrease in the upward trend

[40] One possible (yet to be explored) explanation are changes in R&D tax credits (Bloom, Schankerman, and Van Reenen (2013)). Many of these originated in 1981 (a period of increase in Figure 9b).

of 70%. We view this basic result as a validation that our measure significantly attenuates the increasing downward bias that results from increasing intangible investments over time.

8 Conclusion

Despite the growing importance of intangible capital in today's economy, existing research still lacks a consensus regarding the parameters that govern the capitalization of intangible assets. We develop and test a model that uses market prices to validate parameter estimates of the depreciation of knowledge capital based on prior R&D spending and the fraction of SG&A capital that represents investment into long-lived organizational capital.[41] We estimate the parameters in our model based on market prices from two sources (1) publicly traded equity prices and (2) acquisition prices. Because each sample has a different set of strengths and weaknesses, we develop a set of validation tests to determine the best set of parameters for future research that is based on assessing the ability of the intangible capital stock developed by the parameters in explaining expected outputs from intangible capital investment (e.g. market value, patents, human capital).

For each set of prices, we test two versions - an unadjusted baseline version and a version that attempts to correct potential sample concerns that could induce measurement error to our estimation. We find that the capital stocks estimated by the parameters derived from each sample outperform their baseline counterparts in the main validation test that is based on the explanatory power of market enterprise values by book value estimates that include our measures of intangible capital. Following this result, we subject both sets of adjusted capital stocks to a series of validation tests where their performance is benchmarked against existing estimates. Overall, we find that capital stocks developed via acquisition-adjusted price parameters perform best in these validation tests, showing performance improvements in the stocks' ability to explain market enterprise values, expected returns, human capital, job satisfaction, brand rankings, patent values and trademarks.

[41] Implied stocks and estimation parameters are available for public download and usage at `http://bit.ly/intan_cap`.

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9 Figures and tables

Figure 1: Capital expenditures, R&D and SG&A: 1977–2017

The figure reports the sum of capital expenditures ('capex'), R&D ('xrd') and SG&A ('xsga') for Compustat firms outside of finance, mining, real estate and utilities, scaled by the total sales in the year (2012 dollars).

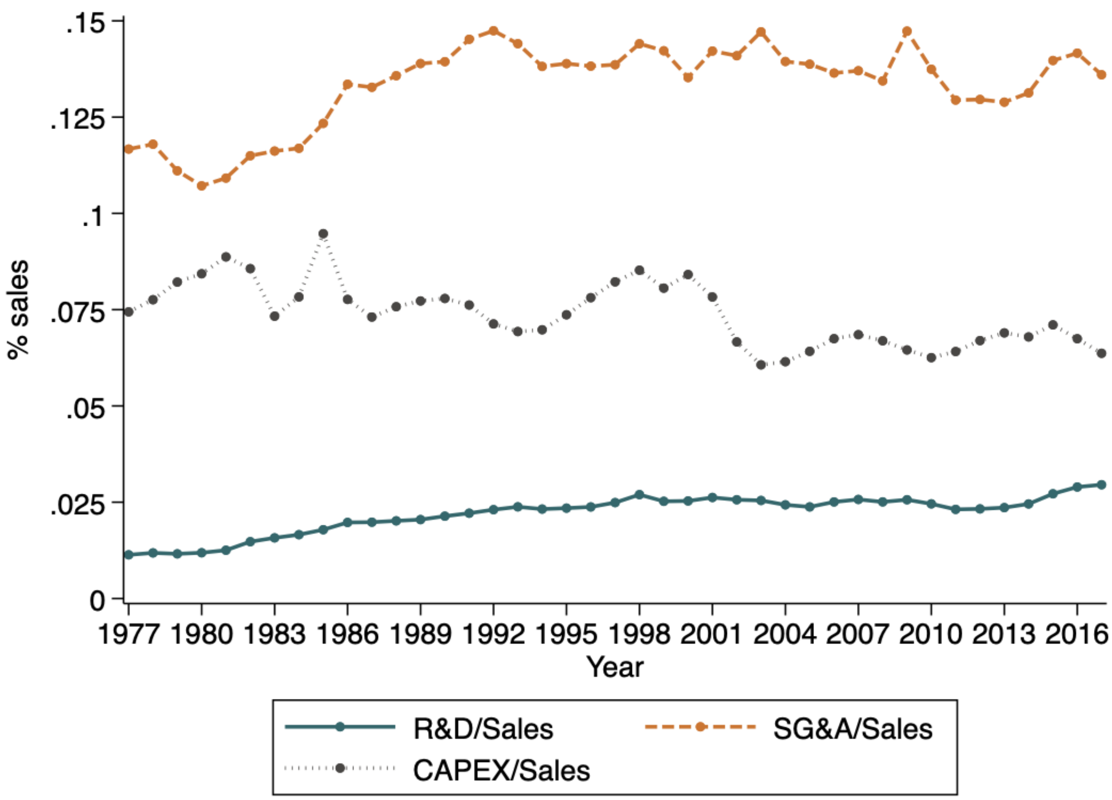


Figure 2: Explanatory power vs BEA-HH: Market Enterprise Value regressed on Book

The figure reports the explanatory power of the estimated capital stock relative to a BEA-HH capital stock measurement in annual regressions of the firm's log market enterprise value (market capitalization plus debt and preferred stock) on the log of book value of capital stock:

$$\log(E_{it}) = \alpha + \beta \log(K_{it}^{tot}) + \varepsilon_{it}$$

where E_{it} firm i's year t enterprise value and K_{it}^{tot} is the standard book value of capital stock (Compustat at). The sample excludes all company-years associated with the acquisitions or bankruptcies in the acquisition-adjusted estimation.

Relative explanatory power is plotted by year, and calculated as excess residual variance explained:

$$\frac{RSS^{BEA-HH} - RSS^{Alt}}{RSS^{BEA-HH}}$$

where RSS represents the residual sum of squares from the regression models.

The baseline (i.e. "RSS^{BEA-HH}") is the benchmark "BEA-HH" model that uses the existing estimates of intangible stocks and the Hulten and Hao (2008) γ of 0.3. "RSS^{Alt}" reflects the use of an alternate model based on market prices. A ratio greater than zero indicates that the market-price estimated capital stocks have stronger explanatory power. The "Acquisitions" model estimates intangible stocks using the Acquisition parameter estimates. The "Acquisitions-Adj." model estimates intangible stocks using the adjusted acquisition parameter estimates. The "Compustat" model estimates the intangible stocks using the Compustat parameter estimates. The "Compustat-Adj." model estimates the intangible stocks using the adjusted Compustat parameter estimates.

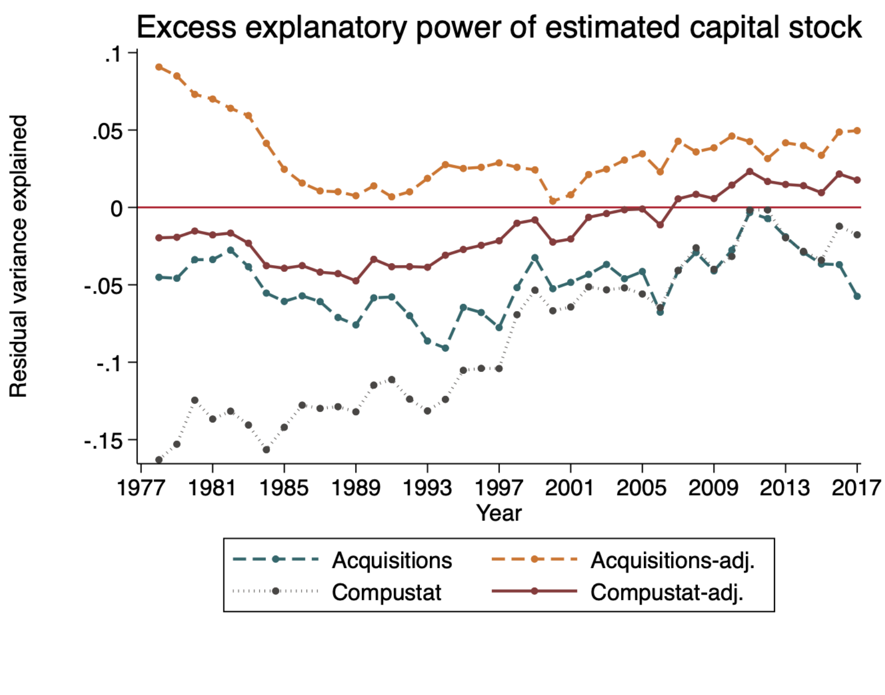


Figure 3: Explanatory power vs BEA-HH: Tests for differences in explanatory power

Using the same regressions described in Figure 2, this figure reports the t-statistics from the test of the hypothesis that the R^2 using each intangible capital alternative is the same as the R^2 from BEA-HH. The test statistic uses the influence function method (Newey and McFadden (1994)) to compare the two separate model statistics. The horizontal lines represent t-statistics of 1.96 and -1.96.

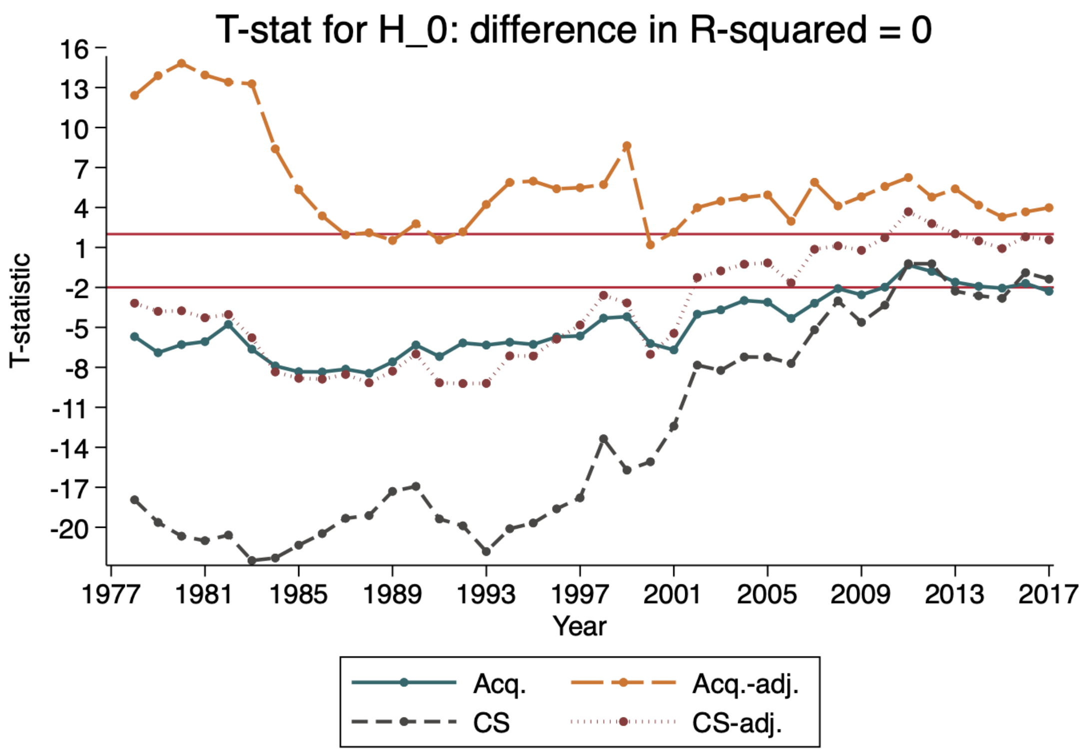


Figure 4: Human capital risk

In each fiscal year, we sort firms into quintiles based on their estimated organizational capital stock using parameter estimates from Table 1. In each firm-year, we set a variable equal to one if the firm's 10-K mentions "personnel", "key talent" or "talented employee," zero otherwise. The figure reports the t-statistics (each year) for the difference in mean test for the top vs. bottom quintiles sorted by each estimation of organizational capital. The red horizontal line is at t = 1.96. "HH" (Hulten and Hao) estimates organizational capital using γ from column (1) of Table 1. "CS-Adj." estimates organizational capital using γ from column (5) of Table 1 and "Acq.-adj." estimates organizational capital using γ column (9). All estimates assume $\delta_S = 0.2$.

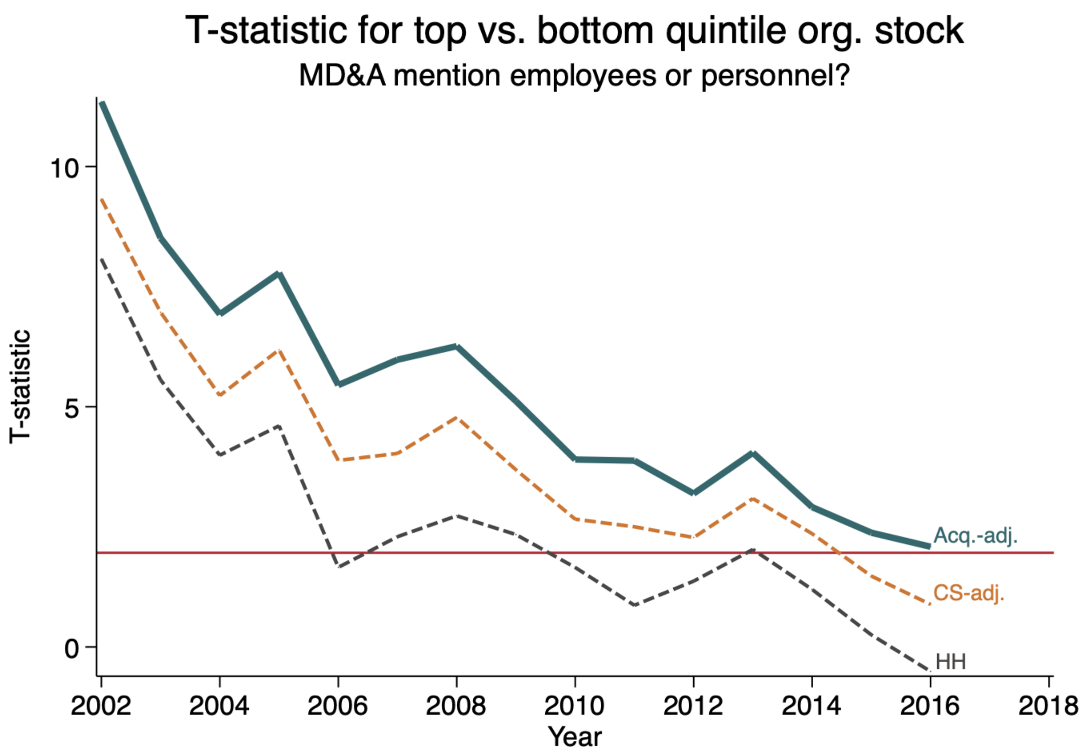


Figure 5: Patent valuations

The figure reports the ratio of R^2 from the following yearly regressions estimated using the BEA-HH parameters in columns (1) and (2) of Table 1 (denominator) and those from the alternative approaches (numerator):

$$\log(\text{Patent}_{it}) = \beta_0 + \beta_1 X_{it} + \beta_2 \log(\hat{G}_{it} + \hat{S}_{it} + I_{it}) + \nu_{it}$$

where Patent_{it} is the patent valuation from Kogan, Papanikolaou, Seru, and Stoffman (2017) (set to zero if there are no patents in the year). The sum $\hat{G}_{it} + \hat{S}_{it} + I_{it}$ is the estimated total intangibles and X_{it} is the lagged patent stock. The two market-price based alternatives to BEA-HH (see Section 3) are the Compustat-Adjusted and Acquisitions-Adjusted samples.

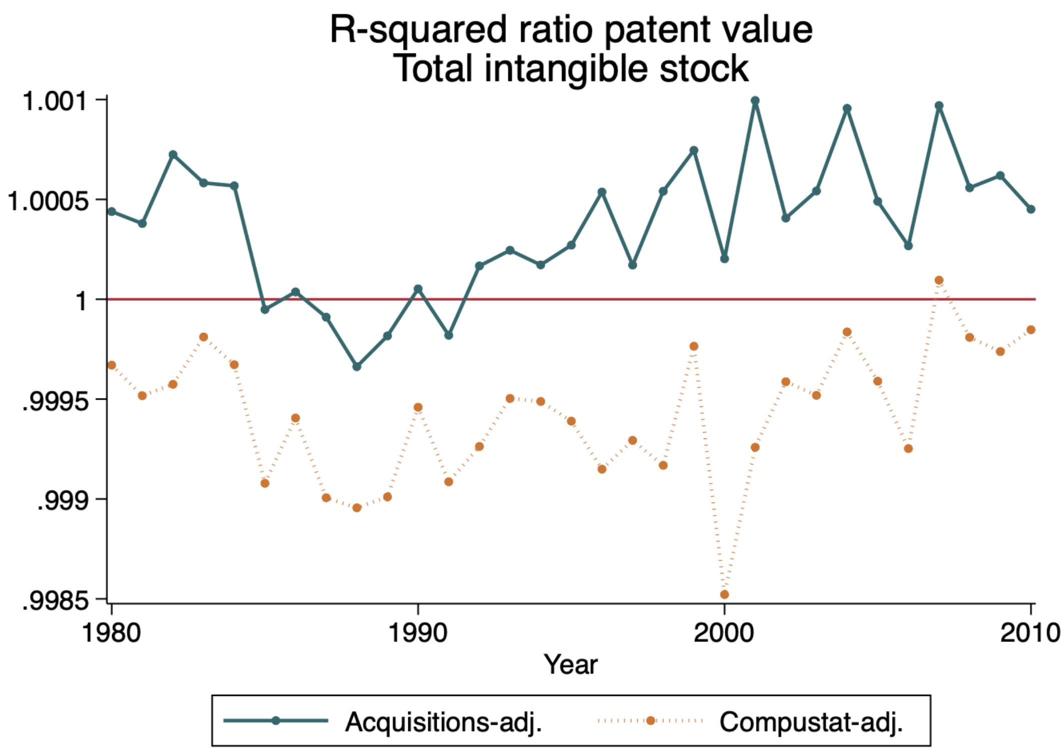


Figure 6: Explaining newly filed trademarks

The figure reports the ratio of R^2 for Acquisitions-adjusted and Compustat-Adjusted (see parameter estimates in Table 1) relative to the R^2 for BEA-HH. We regress the log of total new trademarks plus one ($\text{Trademark}_{it} + 1$) granted in year t (data from Heath and Mace (2020)) on the alternative total intangible stock estimates and lagged trademark stock ($\log(TS_{it-1} + 1)$):

$$\log(\text{Trademark}_{it} + 1) = \alpha_0 + \alpha_1 \log(\hat{S}_{it-1} + \hat{G}_{it-1} + I_{it-1} + 1) + \alpha_2 \log(TS_{it-1} + 1) + \nu_{it}$$

A ratio greater than one indicates the alternative measure provides relatively more explanatory power than the current method in BEA-HH.

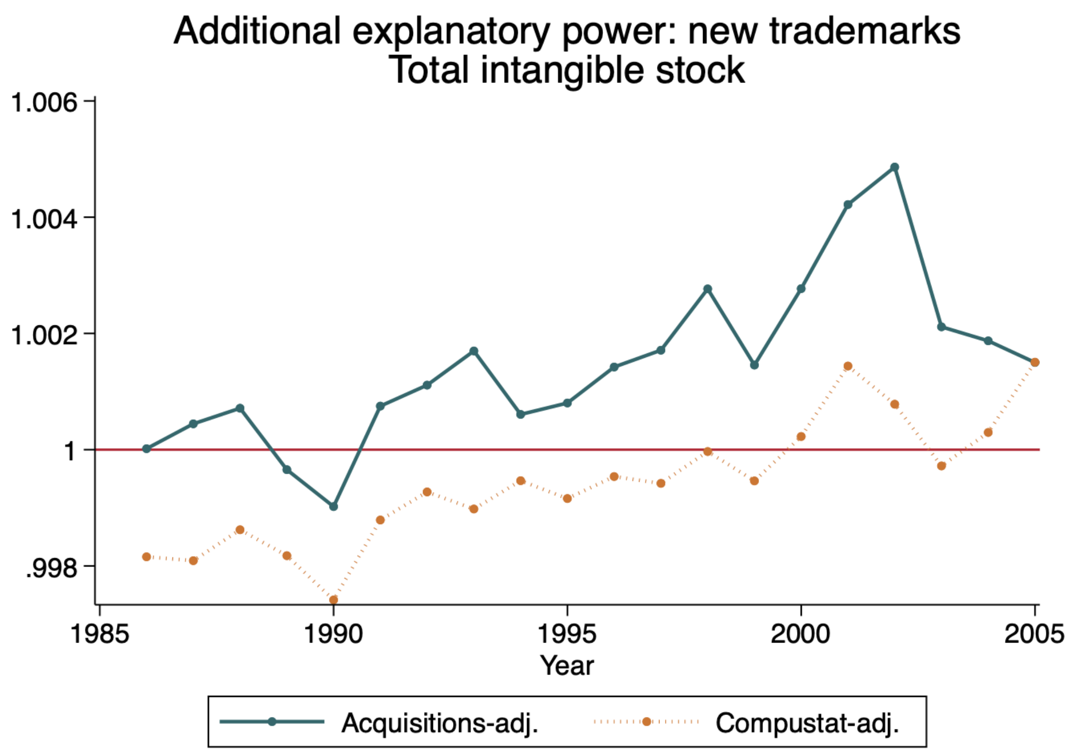


Figure 7: Accumulated returns: alternative HML

The figure presents accumulated log returns for variations of the HML factor from July 1976 to December 2018. The HML factors are constructed using the methodology of Fama and French (1993), with potential modifications to the definition of book equity. "FF standard" uses the definition of book equity from Fama and French (1993). "FF+BEA-HH" is constructed by adding to book equity the measure of the intangible capital stock calculated using the BEA-HH parameters. "FF+Acq.-adj." and "FF+CS-adj." are constructed by adding to book equity intangible capital stocks capitalized using the estimated parameters in Table 1.

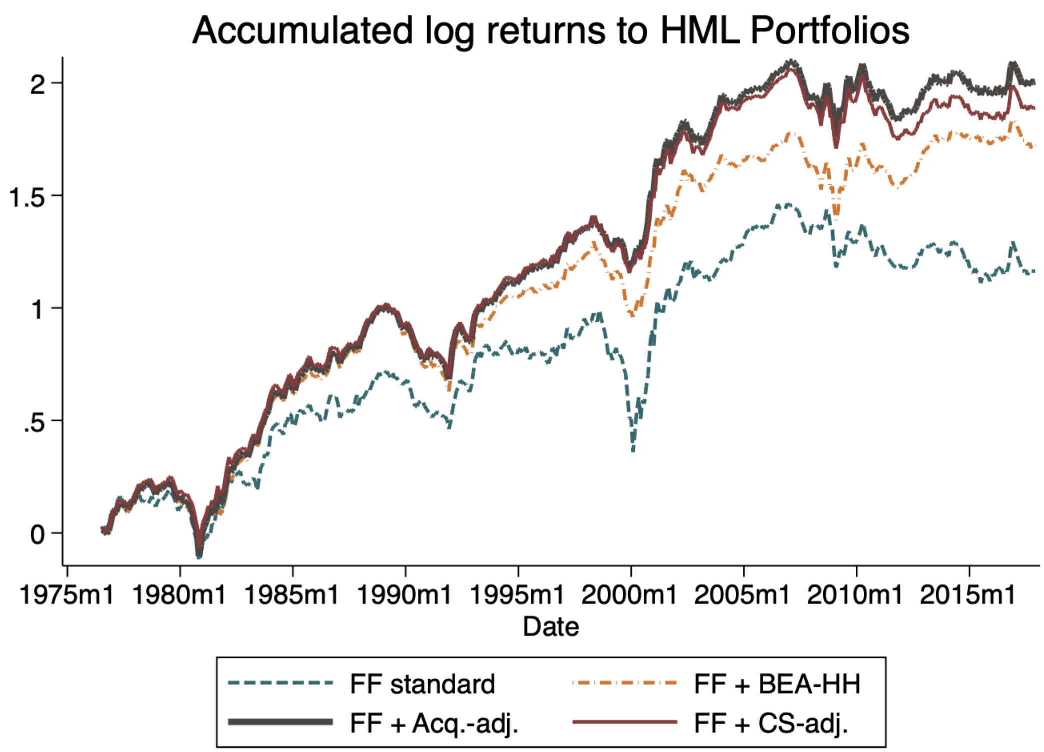


Figure 8: Differences in the size of estimated intangibles vs BEA-HH

The figure reports percent difference between the stocks constructed using BEA-HH and the Acquisition-Adjusted (see Section 3) parameter estimates. A positive percentage difference implies that the alternative measure of intangible stock is larger than BEA-HH. Averages by year and within-industry are reported.

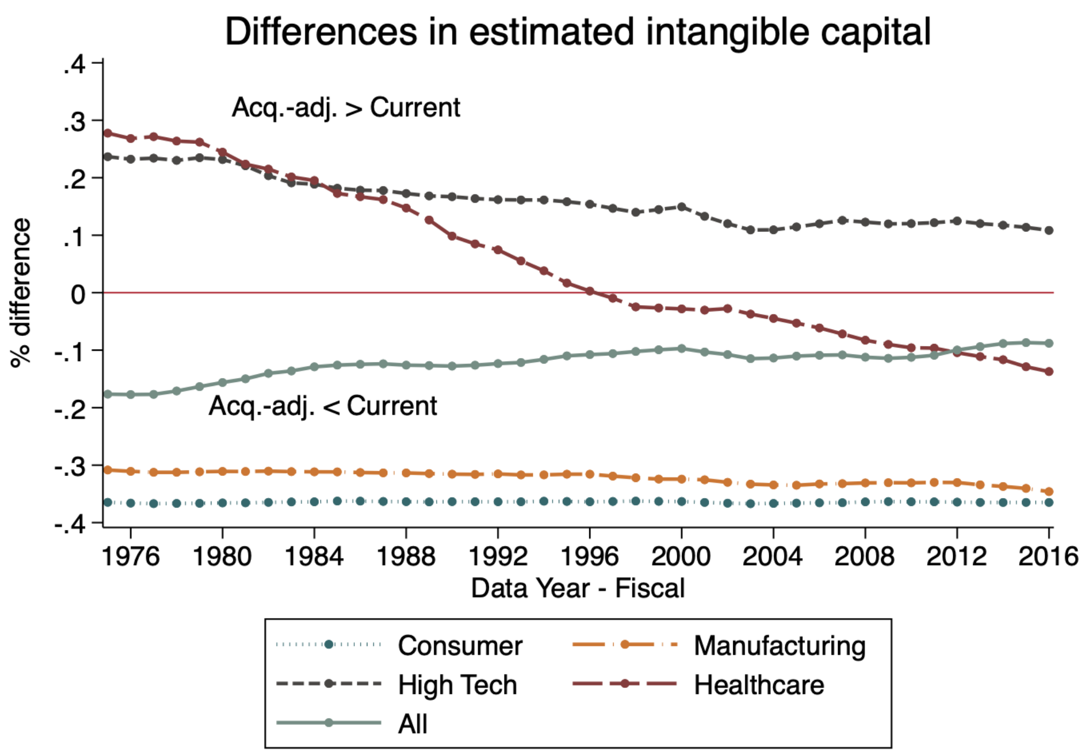
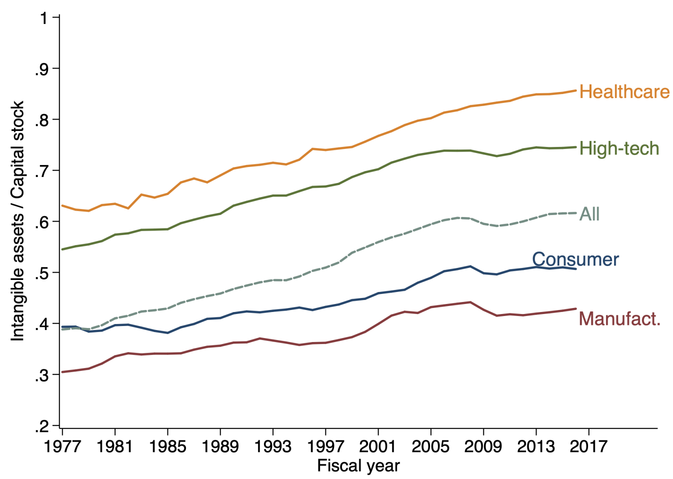


Figure 9: Intangible assets intensities

(a) Intangible asset intensity

The figure reports the ratio of total intangibles – capitalized using the Acquisitions-adjusted method and those on the balance sheet – scaled by total capital stock (PPE + intangibles): $\frac{K^{int}}{K^{int}+K^{phy}}$. across all (mean) firms within each industry-year. K^{int} is the sum of knowledge and organizational capital using the estimates from Table 1 and a firm's previous 10 years of R&D and SG&A expenditures and its externally acquired goodwill and intangibles. K^{phy} is the firm's PPE (gross). The "All" line reports the mean across all firms. The "Other" industry is not reported separated, but included in the "All" series.



(b) Knowledge capital as a fraction of total intangible capital

The figure reports of the ratio of knowledge capital – the accumulated R&D using the estimates from the "Acqusitions-adj." columns of Table 1 – to total intangibles (sum of knowledge and organizational capital) averaged across all firms in each industry-year.

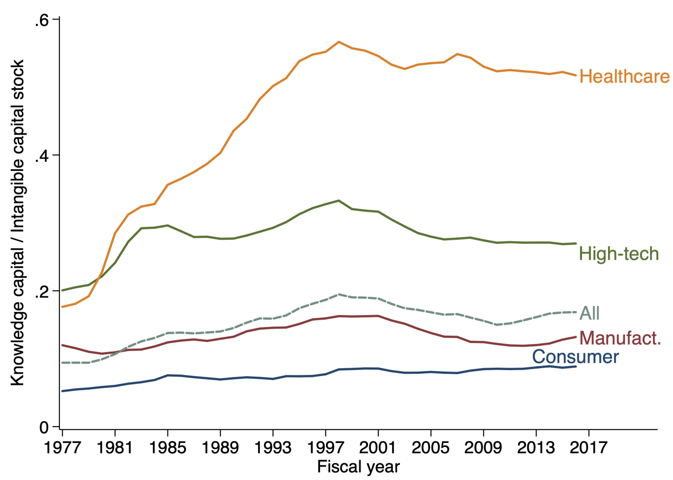


Figure 10: Market-to-book ratios with and without acquisition-adjusted intangibles: 1977–2017

The figure reports the average (2.5% tail winsorized) market-to-book ratios for Compustat firms outside of financials, mining, real estate, utilities and all acquiring firms in our sample. The numerator in both series is the sum of market value of equity at the end of the fiscal year, total liabilities and book preferred stock. For the blue circle series, the denominator is total assets (including acquired intangibles). For the green diamond series, the denominator also includes the knowledge and organizational capital stocks estimated using the Acquisition-Adjusted parameters in Columns (9) and (10) of Table 1. The two dotted red lines present the simple linear fit of each series.

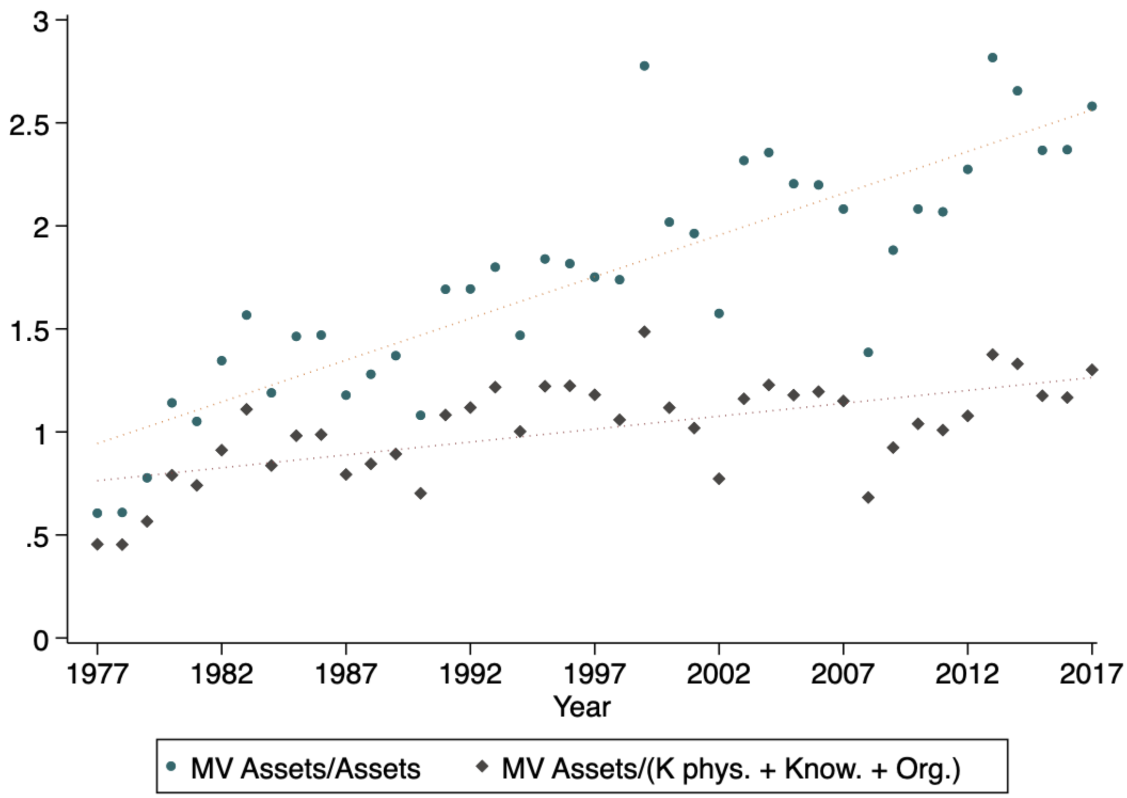


Table 1: Parameter Estimates from Non-linear Least Squares Estimation

Parameter estimates are based on non-linear least squares regressions of the price of intangible firm assets on accumulated intangible assets:

$$log(1 + P^I_{it}) = log(\rho_t) + log(I_{it} + \sum_{k=1}^{10}(1 - \delta_G)^k \text{R\&D}_{i,t-k} + \sum_{k=1}^{10}(1 - 0.2)^k \gamma \text{SG\&A}_{i,t-k} + 1)$$

where P^I_{it} is the price of the firm's total intangible capital as discussed in Section 3 and I_{it} is the target's externally-acquired intangibles reported to the balance sheet pre-acquisition. The year fixed effects (ρ_t) are constrained to an average of 0 (log of 1) across all years. The "All" row reports the pooled sample estimates, while all other rows are separate estimations for the Fama-French 5 industry classifications. Firms can have up to ten years of financial data.

Columns (1) and (2) summarize the parameters used in the BEA-HH methodology discussed in Section 1.3. Columns (3)-(6) report parameter estimates from the Compustat sample defined in Section 3.1 where Columns (3) and (4) calculate the value of intangible assets assuming the market value of intangibles is the remainder value of the firm after removing book assets and columns (5) and (6) mark up the book value of Property, Plant and Equipment to the gross book value. Columns (7)-(10) report parameter estimates from the sample of firm exits discussed in Section 3.2. Columns (7) and (8) report results from the sample of acquisitions only while (9) and (10) report results using the sample of all exits, including failures. In the case of firm failures, acquisition prices are the average debt-holder recovery from bankruptcy available from Moody's Analytics or the average recovery by four-digit SIC code where using the book value of debt prior to the failure. To get total intangibles for failures, we use the average fraction of acquired intangibles to total deal size in the same industry from the acquisition sample.

In each pair of columns, the first reports the estimates of γ, the fraction of SG&A that is investment. The δ_S is assumed to be 0.2 (i.e., not estimated). The δ_G column reports the estimate of R&D depreciation rate. Pseudo R^2 estimates are calculated as the percent improvement in the exponentiated root mean squared error relative to a model which includes only a constant. Column (2) reports the average R&D depreciation rates from Li and Hall (2016) for SIC codes in each of the major industry groups (one obs. per SIC). Bootstrapped (1000 replications at the firm-level) standard errors reported in parentheses. N reports the number of unique firms in the estimation.

	BEA-HH		CS-Net		CS - Gross		Exits-Acq		Exits - Adj	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	γ_S	δ_G	γ_S	δ_G	γ_S	δ_G	γ_S	δ_G	γ_S	δ_G
All	0.30	0.28	0.59	0.23	0.39	0.28	0.43	0.27	0.27	0.33
			(0.014)	(0.012)	(0.012)	(0.012)	(0.039)	(0.039)	(0.026)	(0.038)
Consumer	0.30	0.31	0.49	0.11	0.31	0.20	0.38	0.31	0.19	0.33
			(0.014)	(0.107)	(0.013)	(0.064)	(0.055)	(0.335)	(0.027)	(0.317)
Manufacturing	0.30	0.25	0.63	0.22	0.33	0.32	0.24	0.23	0.22	0.42
			(0.026)	(0.076)	(0.016)	(0.043)	(0.078)	(0.209)	(0.055)	(0.163)
High Tech	0.30	0.31	0.62	0.28	0.47	0.34	0.58	0.39	0.44	0.46
			(0.022)	(0.015)	(0.026)	(0.051)	(0.075)	(0.065)	(0.060)	(0.072)
Health	0.30	0.18	0.64	0.24	0.49	0.26	0.62	0.23	0.49	0.34
			(0.041)	(0.020)	(0.039)	(0.020)	(0.194)	(0.075)	(0.138)	(0.065)
Other	0.30	N/A	0.77	0.07	0.63	0.15	0.52	-0.14	0.34	0.30
			(0.032)	(0.076)	(0.031)	(0.093)	(0.116)	(0.232)	(0.062)	(0.184)
Pseudo-R^2			0.344		0.340		0.425		0.515	
N			14,876		14,876		1,521		2,000	

Table 2: Brand ranking

The table reports the OLS estimates from a regression of log brand ranking on measures of intangible capital estimated from BEA-HH, Compustat-Adjusted, and Acquisitions-Adjusted sample. Brand rankings are from the Interbrand listings which are merged to Compustat U.S. public companies. A unit of observation is a firm-year. "Log org. K (BEA-HH)" is the log of organizational capital using the BEA-HH parameters from Table 1. "Log org. K (Acq.)" and "Log org. K (Compustat)" show the same estimated stocks using the acquisition-adjusted and Compustat-adjusted parameter estimates. "Log total intan. K" is the sum of externally acquired intangibles, estimated knowledge capital and estimated organizational capital. "Year FE" are fixed effects for fiscal year. Robust standard errors reported in parentheses. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level.

	Log of brand ranking					
	(1)	(2)	(3)	(4)	(5)	(6)
Log org. K (HH)	-0.044***					
	(0.0080)					
Log org. K (Acq.)		-0.053***				
		(0.0083)				
Log org. K (Compustat)			-0.045***			
			(0.0078)			
Log total intan. K (BEA-HH)				-0.21***		
				(0.026)		
Log total intan. K (Acq.)					-0.23***	
					(0.026)	
Log total intan. K (Compustat)						-0.22***
						(0.026)
Observations	1122	1122	1122	1122	1122	1122
R^2	0.014	0.023	0.017	0.093	0.11	0.10
Year FE?	Y	Y	Y	Y	Y	Y

Table 3: Best company to work for rankings: rank regression and correlations

The table reports the regression estimates and pairwise correlations between the annual "Best Company to Work For" from Edmans (2011) and Glassdoor listings of the same type for later years. The first table regresses the log of brand rank (0 highest) on the ranking of firms in the sample by the three organizational capital stocks. "Rank Org. K" is the ranking of firms in this sample using the knowledge capital estimate from BEA-HH. "Rank Org. K (Acq.)" uses the estimate from the acquisition-adjusted sample and "Rank Org. K (Compustat)" uses the ranks by Compustat-adjusted estimated stocks. The other rows report ranks by organizational capital ("Org. K") and total intangibles (knowledge plus organizational "Total intan. K"). Robust standard errors in parentheses. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level for non-zero correlation.

Panel A Log company rank: employee satisfaction (0 highest)			
Log org. capital. rank (HH)	0.014		
	(0.030)		
Log org. capital. rank (Acq.-adj.)		0.055*	
		(0.030)	
Log org. capital. rank (CS-adj.)			0.027
			(0.030)
Observations	910	910	910
R^2	0.00020	0.0030	0.00071

Panel B Company rank: employee satisfaction (1 highest)	
Rank Org. K (HH)	0.110***
Rank Org. K (Acq.)	0.162***
Rank Org. K (Compustat)	0.134***
Rank Know. K (BEA)	0.126***
Rank Know. K (Acq.)	0.150***
Rank Know. K (Compustat)	0.137***
Rank Total intan. K (BEA-HH)	0.114***
Rank Total intan. K (Acq.)	0.139***
Rank Total intan. K (Compustat)	0.127***

Table 4: The value premium: including intangibles in book value

The table reports summary statistics for HML portfolio returns for three measures of book equity from 1976 through 2017. The Fama-French HML is constructed as in Fama and French (1992). The BEA-HH HML is similarly constructed, but augmented with the BEA-HH measure of internally generated intangible assets. The Compustat-adjusted and acquisitions-adjusted HML portfolios are instead augmented with the intangible capital stocks implied by the parameters in table 1. Returns are reported in percentage points per month. The column "P(=FF)" reports the p-value of the t-test with the null hypothesis that the mean of the monthly returns is equal to that of the traditional HML measure. The Sharpe ratio is annualized.

HML	Obs	Mean	P(=FF)	St. Dev.	Sharpe
Fama-French	498	0.28		2.96	0.32
BEA-HH	498	0.38	0.12	2.46	0.53
Comp.-adj.	498	0.41	0.10	2.48	0.57
Acq.-adj.	498	0.43	0.05	2.49	0.60

Appendix

Table A1: Variables and definitions of terms

The table presents variable and term definitions used throughout the paper.

Variable/Term	**Definition**
Deal effective year	Year the acquisition was completed.
Year announced	The year that the acquisition was announced to the public.
Services firm (target)	An indicator equal to one if the acquisition target is in the services sector.
Value of transaction (mil)	The total value of the acquisitions (in 2012, USD millions) as reported in SDC.
Target Net Sales LTM (mil)	The last twelve month net sales for the target firm at the time of acquisition (2012 USD).
Target EBITDA LTM (mil)	The last twelve month EBITDA for the target firm at the time of acquisition (2012 USD).
Target total assets	Total assets of the acquired firm at the time of acquisition (2012 USD).
CA HQ (acq.)	An indicator variable that is equal to one if the firm is headquartered in California.
NY HQ	An indicator variable that is equal to one if the firm is headquartered in New York state.
Intangible assets (IIA)	The total identified intangible assets from the acquisition revealed through the purchase price allocation. Reported in millions (2012 USD).
Goodwill (mil)	The total goodwill allocated in the acquisition (2012 USD).
Goodwill (adj., mil)	The total goodwill net of an estimate of synergy and any over/under-payment of the target by the acquirer. The former is approximated by the sum of the product of 2-day window cumulative abnormal (CAR) and pre-deal market value for both target and acquirer, while the latter is the negative of the acquirer's CAR times the pre-deal market valuation.
All stock	An indicator variable equal to one if the acquisition was an all-stock deal.
All cash	An indicator variable equal to one if the acquisition was an all-cash deal.
Balance sheet intan.	The total intangible assets already on the balance sheet of the firm, typically from past acquisitions of intangibles and goodwill.
Organizational capital	The capitalization of some fraction γ of SG&A expenditures by a firm. It is meant to capture the knowledge used to combine human skills and tangible capital into systems for producing and delivering want-satisfying products.
Knowledge capital	The consensus proxy for the flows of a firm's knowledge capital in the intangibles literature is its periodic disclosure of research and development expenditures.
BEA-HH	The acronym for the depreciation parameter assumptions from Li and Hall (2016) for knowledge capital and the fraction of SG&A that is investment from Hulten and Hao (2008).

A1 Acquisition accounting

The U.S. General Accepted Accounting Principles (GAAP) treatment for business acquisition has evolved significantly over time. This section constitutes a brief overview of the guidelines and principles provided by the FASB, and discusses their differential impact to the financial statements of the acquiring firm.

From 1970 until 2001, Accounting Principles Board (APB) Opinion No. 16 stated that "the purchase method and the pooling of interests method are both acceptable in accounting for business combinations, although not as alternatives for the same business combination." If the acquiring firm was in accordance with a list of specified conditions, it would account for the transaction as a pooling acquisition, otherwise it would use the purchase method.

In the purchase method, the acquirer restates all of the target's net assets to their fair value and records the difference between the fair value of the acquirer's consideration and the fair value of the target's net assets as goodwill. The acquirer's goodwill asset would then be subjected to annual impairment tests if the carrying value of goodwill related to the reporting unit is suspected to be less than its fair value.[42] In the pooling method, the acquirer must finance the purchase entirely with stock. The assets and liabilities of the target firm are combined with the acquirer at book value, essentially implying that fair market values of the acquirer's consideration and the target's net assets are ignored for accounting purposes. The target firm's retained earnings are aggregated together with the acquirer's retained earnings. Equity shares issued by the acquirer for the purchase are recorded based upon book value of the target's net assets. Because of this, no excess of acquisition cost over the target's book value of net assets exists, and thus no new goodwill is recorded to the acquirer. Studies that have examined the firm's use of purchase versus pooling methods have generally found that the larger the difference between the book value of the target's asset and the price paid by the acquirer, the more likely that the acquirer will opt for the pooling method (Robinson and Shane (1990); Ayers, Lefanowicz, and Robinson (2000)). This is because the purchase method would result in the target's net assets being marked to market and any goodwill added to the acquirer's balance sheet being depreciated and amortized over time, resulting in an additional expense against the firm's reported profits in the subsequent years. As discussed below, any acquisitions using the pooling method cannot be used in our analysis.

On December 15, 2001 FASB enacted FAS 141[43], which eliminated the use of pooling-of-interest accounting in acquisitions.[44] At the same time, FAS 141 eliminated the amortization of purchased

[42] Prior to 2001, goodwill was amortized using a straight-line depreciation method over a period not to exceed forty years.

[43] `https://www.fasb.org/summary/stsum141.shtml`

[44] The FASB justified the elimination of the pooling method because "the purchase method, as modified by the board during deliberations, reflects the underlying economics of business combinations by requiring that the

goodwill. Instead, goodwill would be considered an indefinite life asset, and amounts on the acquirer's books would be subject to "impairment" tests, which would be conducted when expectations for the reporting unit have been significantly reduced. At this time, the goodwill would be revalued and compared with its carrying book value, with any differences being expensed as a write-off for the acquiring firm.[45]

On December 15, 2007, FASB superseded FAS 141 with FAS 141R (now referred to as ASC 805 as of September 15, 2009).[46] ASC 805 stands as the current method of accounting for acquisitions. This method, known as the "acquisition method" is similar to the purchase method for acquisitions, with a few notable adjustments. (1) In FAS 141, there was no forced recognition of contingent assets or liabilities being acquired. Under FAS 141R, guidance for the recognition of contingent assets and liabilities depends on whether the contingencies are contractual, such as a warranty agreement, or non-contractual, such as the outcome of a lawsuit. Contractual contingencies are accounted for at fair value, while non-contractual contingencies are accounted for if the probability of realization of the contingent asset is greater than fifty percent. (2) In FAS 141, transaction costs such as legal fees, banking fees or other direct acquisition costs were included in the purchase price allocation, where as in FAS 141R they are recorded as expenses. (3) In FAS 141, in-process research and development (IPR&D) could be expensed immediately upon completion of the acquisition if the acquired IPR&D has no alternate use. In FAS 141R, IPR&D exists as an indefinite-lived intangible asset until the completion or abandonment of the associated R&D project.

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current values of the assets and liabilities exchanged be reported to investors. Without the information that the purchase method provides, investors are left in the dark as to the real cost of one company buying another and, as a result, are unable to track future returns on the investment." See http://ww2.cfo.com/2001/01/fasb-reaffirms-plan-to-eliminate-pooling-updated-2/

[45]For example, on April 25, 2014 Microsoft acquired the mobile hardware division of Nokia for $7.9 billion. In 2015, they announced a goodwill write-off of $7.5 billion related to the Nokia acquisition. In note 10 of the 10-K, they cite the following reason for the impairment: "Upon completion of the annual testing as of May 1, 2015, Phone Hardware goodwill was determined to be impaired. In the second half of fiscal year 2015, Phone Hardware did not meet its sales volume and revenue goals, and the mix of units sold had lower margins than planned. These results, along with changes in the competitive marketplace and an evaluation of business priorities, led to a shift in strategic direction and reduced future revenue and profitability expectations for the business. As a result of these changes in strategy and expectations, we have forecasted reductions in unit volume growth rates and lower future cash flows used to estimate the fair value of the Phone Hardware reporting unit, which resulted in the determination that an impairment adjustment was required." https://www.sec.gov/Archives/edgar/data/789019/000119312515272806/d918813d10k.htm

[46]https://www.fasb.org/pdf/fas141r.pdf

A2 Details on Acquisition Sample Construction

A2.1 Sample Construction

We require data availability of the acquirer's purchase price allocation of the target's assets in order to collect the prices paid for goodwill and identifiable intangible assets (IIA). When available, these purchase price allocations were found in the acquirer's subsequent 10-K, 10-Q, 8-K or S-4 filing. We found information on the purchase price allocation for 81% (1,719) of all candidate acquisitions.[47] In the final step, we merge the target and acquirer firms to Compustat and CRSP. For each target firm merged to Compustat, we gather up to 10 years of the firm's past R&D and SG&A expenditures along with any pre-acquisition acquired intangibles on its balance sheet.[48,49] The final sample includes 1,521 events (70%). Below we describe how these deals differ from those lost in the data collection process.

Any remaining selection issues after incorporating bankruptcies take one of two forms. If most acquisition targets are low productivity innovators (e.g., Bena and Li (2014)), then we may estimate too high a depreciation rate and too low a value of γ. Alternatively, acquired firms may on average represent firms with successful innovation projects or that are purchased at the peak of their innovative productivity. In this case, we would estimate too low a depreciation rate and/or too high a fraction of organizational capital investment (γ). It is not clear which source of selection issues dominate, so we use the well-identified parameter estimates from Li and Hall (2016) to help judge our estimates. Since their estimation of depreciation parameters for R&D is derived from a representative set of firms (from a small set of industries), a lack of systematic differences with our estimates would indicate that our sample selection is not severe.[50]

A2.2 Synergy and overpayment: adjusting goodwill

Acquisitions may be motivated by pair-specific synergy values, and prior research has documented that managers may overpay for a target due to agency frictions or hubris (e.g., Roll (1986)). These issues could potentially affect the representativeness of our imputed parameter estimates when applied to the full population of firms. Extending our parameter estimates to all publicly

[47] Some filings lacked the footnote for the acquisition (e.g., the acquisition was immaterial) or we could not identify any filing for the acquiring firm (e.g., the firm has a unique registration type with the SEC).

[48] If Compustat has less than 10 years of data and the firm is older than 10 years old, then we impute any missing R&D and SG&A using observed growth rates for the same age firms with non-missing data. All results are robust to excluding these imputed data.

[49] We also lose acquisitions because we either failed to find a Compustat identifier or the firm did not have stock price data in CRSP (e.g., it was traded on the OTC markets).

[50] For robustness, we later run all analyses with and without the bankrupt firms and show that the estimates change as predicted.

listed firms requires that the prices paid for intangible capital in our sample represent a *public* or market value. Fortunately, the purchase price allocation process directly separates intangible assets that can be identified via either a separability criterion or previously established contractual legal criterion. Thus, pair-wise values arising from the acquisition – synergies – will be recorded as goodwill. Because we are interested in the stand-alone value of assets, our analyses adjust goodwill accordingly.

To make these adjustments, we apply the market's assessment of synergy value and under/overpayment of the target firm by using changes in the target and acquirer's market valuation around the acquisition event date. We follow the Bhagat, Dong, Hirshleifer, and Noah (2005) framework for estimation merger value creation as an adjustment to goodwill. Specifically, using this probability scaling method for announcement day returns, we estimate the synergy and over-payment component of the acquisition value and then remove this estimate from goodwill valuations from the purchase price allocation.[51] This estimate is removed from goodwill valuations from the purchase price allocation.[52]

For each acquisition event, we first calculate the $[-5, 5]$ day change cumulative abnormal return for both the target and acquirer.[53] Multiplying by the pre-deal ($t = -6$) market value of each gives the abnormal change in market valuation at deal announcement. Next, as the market's response incorporates expectations about merger failures, we weight them by the inverse of the probability of acquisition success implied by the end-of-period market price of the target compared to the offer price in the deal.[54] The sum of the target and acquirer's changes – the expected synergy – is subtracted from goodwill.[55] We remove the acquirer's change in valuation as it incorporates under/overpayment. Here, a decline in the acquirer's market value would signal overpayment for the target, leading to goodwill that is abnormally large when compared to payment at fair market value; as such, this overpayment must be removed from goodwill. We find that the goodwill adjustments to be substantial, with the average (median) deal adjustment resulting in a 34% (21%) decline in goodwill.[56]

[51] We cannot easily implement the second "intervention method" with our relatively small sample size.

[52] In cases where the adjustment exceeds goodwill (less than 15% of deals), the remainder is removed from the IIA valuation.

[53] The estimates below are robust to 2, 4 and 30 day event windows.

[54] That is, the probability of a successful merger is $\frac{P_1 - P_0}{P_{\text{offer}} - P_0}$, where P_1 is the end-of-day target share price, P_0 is the pre-announcement share price and P_{offer} is the original offer price. For example, if the pre-announcement price is 100 and the tender offer is 200, an end-of-day share price of 170 implies a 70% probability of deal completion. When this is unavailable or outside the unit interval, we use the observed success rate in SDC over our sample period (78%).

[55] If the result is negative, then the remainder is subtracted from the identifiable intangible assets.

[56] Internet Appendix Figure IA4 reports the percentage of acquisition deal size allocated to goodwill and IIA after these adjustments. The prevalence of goodwill in deal size falls in all years (see the green arrows), which has an impact on the total intangible value in acquisitions.

A2.3 Main variables

Figure A1 (a) shows the prevalence of goodwill and IIA for our acquisition sample. It reports the percentage of all deals that have some amount of either asset in the purchase price allocation. We observe an upward trend in these components since the mid-1990s, with over 85% of deals containing goodwill or IIA since 2004. To ensure that our observations are not driven by smaller acquisitions, Figure A1 (b) repeats the analysis but replaces the y-axis with a dollar-weighted measure, which is the sum of all IIA and goodwill in the sample, scaled by the sum of all acquisition deal sizes in the sample. The patterns remain. Figure A2 asks how much of the total enterprise value is comprised of goodwill and IIA. The latter represents 25% of total transaction value over the sample period, while the former accounts for approximately 35% of the typical deal size over the full sample period. This suggests that intangibles play a major role in the U.S. acquisition market.

A2.4 Summary statistics

Panel A of Table A2 presents summary statistics on deals and the parties. All dollar values are in 2012 dollars. The average deal year is 2005 with an average (median) deal size of $2.3b ($426m). Deal size as measured by enterprise value (thus including assumed liabilities) averages $2.5b. We assign firm industries using the Fama-French 5 industry classification. Consumer firms represent 18% of targets, while the average target has an EBITDA of $142m. Over one-quarter of the acquirers are headquartered in California, which is slightly above the rate for all public firms. This is likely a consequence of both our focus on acquisitions and our requirements for observability of the purchase price allocation for intangibles. We also see that goodwill is on average $1.1b with a much lower median of $159m.[57] IIA comprises 38% of total intangible capital (goodwill plus IIA) on average. Finally, total intangibles represent 75% of enterprise deal size on average. In 281 acquisitions, the total intangible capital exceeds the enterprise value of the firm. We randomly checked 20 acquisitions in this sub-sample and verified that this is a result of the target's net tangible assets being less than zero. Correspondingly, we found that these targets tended to be high-tech or healthcare targets with very high R&D and SG&A expenditures and very low levels of PP&E on their balance sheets.

[57]In a few of our observations, total intangibles (identifiable intangible assets and goodwill) is negative. These instances, while rare, occur because goodwill can take on negative values and in these cases, the negative value is larger than the value of identifiable intangible assets. Since goodwill is the plug variable that equates the balance sheet, negative goodwill occurs when the acquirer is able to purchase the target at a price that is below the fair value of net tangible assets that is measured during the due diligence appraisal. This negative goodwill is immediately recorded to the income statement as an extraordinary gain. See Figure IA3 in the Internet Appendix for an example. We allow goodwill to be negative, but because the estimation is done in logs we bottom code total intangibles to zero.

Panel B of Table A2 summarizes the acquisitions in the bankrupt firm sample. The average failure date in our sample is earlier than the acquisition date (2002 vs. 2004). In fact, over a quarter of the delistings in our sample occur in years 2000 and 2001, the burst of the e-commerce dot-com bubble. In contrast to acquired firms, These firms are more to be in the consumer industry (34% vs. 18%). Not surprisingly, the average failed firm tends to be small and unprofitable with an average asset size of $252m and net loss of $80m. Total intangibles – which are estimated as a function of the "deal size" defined in the previous section – are small with an average of $35m, keeping in mind that we make no assumption about the breakdown of goodwill or identifiable intangibles, only the total.

A2.5 Selection of acquisitions

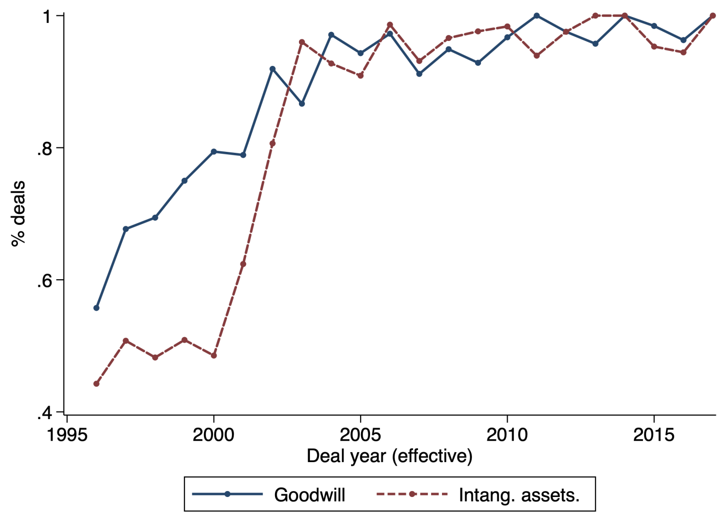
Our final acquisition sample (excluding delistings from bankruptcies) excludes 588 deals in which an extensive search failed to find the purchase price allocation. Thus, inferences derived using this final acquisition sample should address these potential sample selection issues. Fortunately, Table A3 shows that our sample of acquisitions is reasonably similar to those excluded. The right-most columns present the excluded acquisitions. These acquisitions occurred earlier in the sample, are less likely to be in manufacturing, and have a smaller median deal size ($177 vs. $385m). The smaller size implies these acquisitions are more likely to be immaterial to the acquirer and, consequently, to not have a purchase price allocation in their filings. Reassuringly, the targets are not significantly smaller in the excluded group when measured by pre-acquisition assets or net sales. Overall, Table A3 shows that our acquisition sample likely tilts toward larger deals and more recent events. The inclusion of delisted firms – with low assumed "acquisition" values and no time period constraints – helps to balance many of these differences out.

A10 Appendix Figures and Tables

Figure A1: Percentage of acquisition deals with non-zero intangible assets or goodwill

The figure in Panel A reports the percentage of all acquisitions in the sample (see Section 3) that have non-zero intangible assets or goodwill acquired. The deals included are those where we could find a purchase price allocation in the target's 10-K, 10-Q, S-4 or 8-K. Panel B reports the percentage of all deal dollars in our sample of acquisitions (see Section 3) associated with deals that have non-zero goodwill or intangible assets acquired. So the "Goodwill" figure is the annual sum of transactions with some positive goodwill divided by the total amount of transaction dollars in that year.

(a) Prevalence of IIA and goodwill



(b) Deal-weighted

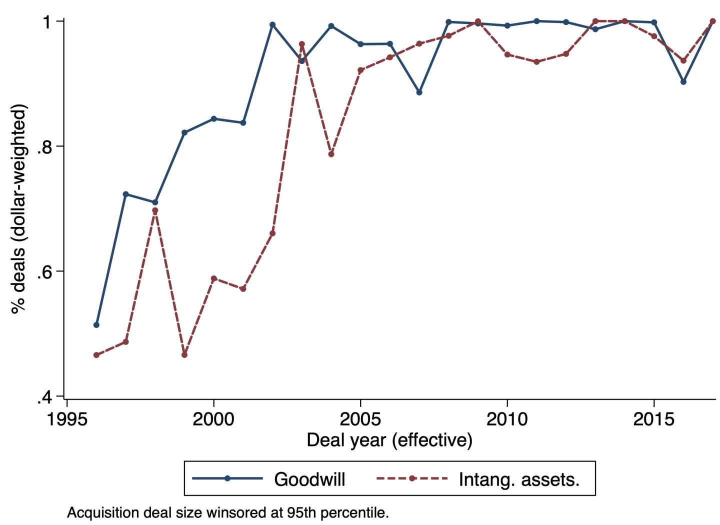


Figure A2: Percentage of acquisition deal size for intangible assets

The figure reports the average percentage of an acquisition deal size (i.e., enterprise value of the deal) attributed to goodwill, intangible assets (IIA) and their sum. The sample is the subset of acquisitions (see Section 3) associated with deals that have non-zero goodwill or intangible assets acquired.

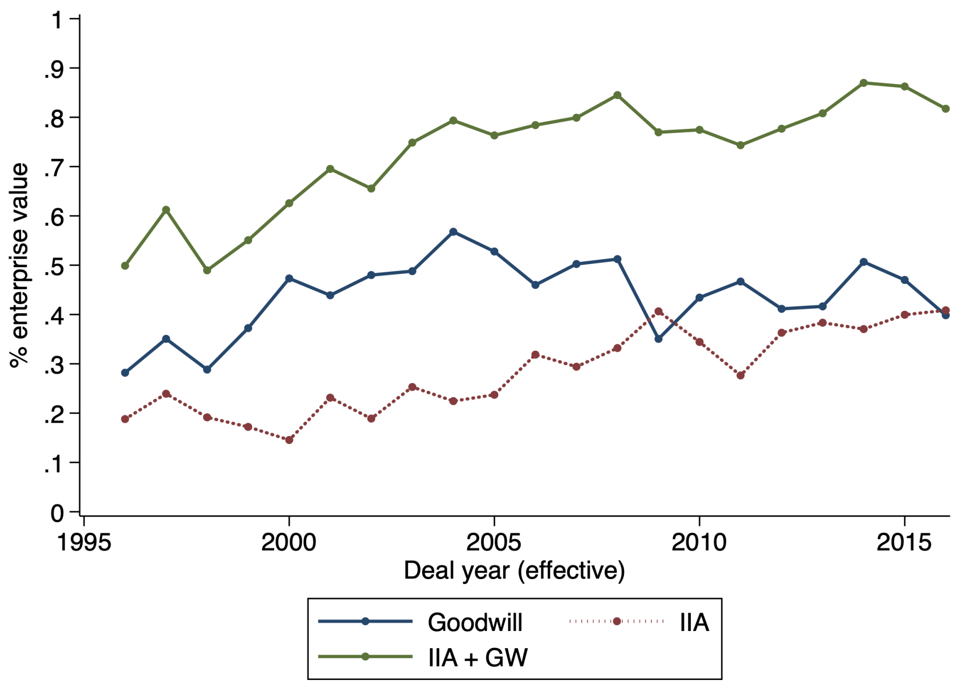


Table A2: Summary statistics for sample of found deals in model estimation.

Summary statistics for observable characteristics of deals, targets and acquirers for the sample of acquisitions in the main estimation. Panel A reports the characteristics of the acquisition sample and Panel B reports the characteristics of the failure sample. Variable definitions found in Appendix Table A1.

	Panel A: Deals in model sample (acquisitions)					
	Obs	Mean	Min.	Median	Max	Std dev
Deal effective year	1,521	2005.02	1996.00	2004.00	2017.00	6.02
Year announced	1,521	2004.72	1995.00	2004.00	2017.00	6.02
Manufacturing firm (target)	1,521	0.11	0.00	0.00	1.00	0.31
Consumer firm (target)	1,521	0.23	0.00	0.00	1.00	0.42
High-tech firm (target)	1,521	0.40	0.00	0.00	1.00	0.49
Enterprise value of transaction (mil)	1,521	2522.25	0.80	444.28	235456.36	9583.32
Value of Transaction (mil)	1,521	2145.85	0.59	385.22	213641.79	8329.79
Target EBITDA LTM (mil)	1,457	142.92	-7430.77	13.78	14080.53	718.85
Target Total Assets (mil)	1,503	1205.32	0.43	200.76	66446.13	4359.60
Target Net Sales LTM (mil)	1,489	1113.10	-35.17	193.75	67343.40	3763.57
CA HQ (target)	1,521	0.28	0.00	0.00	1.00	0.45
NY HQ (target)	1,521	0.06	0.00	0.00	1.00	0.24
CA HQ (acq.)	1,521	0.24	0.00	0.00	1.00	0.43
NY HQ (acq.)	1,521	0.10	0.00	0.00	1.00	0.29
Goodwill (mil)	1,521	1119.79	-5.54	161.11	52730.25	3479.91
Adjusted goodwill (mil)	1,521	772.04	-2985.72	67.21	36460.48	2807.19
Total intangibles (IIA + GW, mil)	1,521	2035.27	-5.54	272.78	170875.33	7999.14
Total intangibles (IIA + Adj. HW, mil)	1,521	1687.52	-1231.19	175.81	167889.61	7527.35
IIA / IIA + GW (if positive)	1,466	0.38	0.00	0.34	1.00	0.32
Total intangibles / Total deal size (all)	1,521	1.31	-0.11	0.85	411.69	11.09
Total intangibles / Total deal size (< 1)	1,051	0.64	-0.11	0.72	1.00	0.29
Total intangibles / Total ent. value (all)	1,521	0.75	-0.10	0.77	35.41	0.96
Total intangibles / Total ent. value (< 1)	1,244	0.63	-0.10	0.70	1.00	0.28

	Panel B: Deals in model sample (failures)					
	Obs	Mean	Min.	Median	Max	Std dev
Year failed	479	2002.99	1996.00	2001.00	2017.00	5.50
Manufacturing firm	479	0.10	0.00	0.00	1.00	0.30
Consumer firm	479	0.37	0.00	0.00	1.00	0.48
High-tech firm	479	0.22	0.00	0.00	1.00	0.41
Total assets (2012 USD)	469	253.29	0.31	67.28	6562.80	628.68
Net income (2012 USD)	444	-80.64	-9919.58	-10.49	95.52	537.74
Total intangibles	452	19.75	0.00	1.57	661.05	58.26

Table A3: Summary statistics for sample of acquisitions in and out of sample.

Summary statistics of deal characteristics of deals in our main sample and those that were excluded. Excluded deals are described in Section 3 and are generally those acquisitions where we could not find the purchase price allocation in the acquirer's financial statements. The starting sample of potential acquisitions were all U.S.-based public firm acquisitions or public targets outside of finance, mining, real estate and utilities from 1996–2017 where we could match both firm's to Compustat.

	Included acquisitions				Excluded acquisitions			
	Obs	Mean	Median	Std dev	Obs	Mean	Median	Std dev
Deal effective year	1,521	2005.02	2004.00	6.02	588	2002.63	2001.00	5.62
Year announced	1,521	2004.72	2004.00	6.02	588	2002.30	2001.00	5.66
Manufacturing firm (target)	1,521	0.11	0.00	0.31	588	0.12	0.00	0.33
Consumer firm (target)	1,521	0.23	0.00	0.42	588	0.28	0.00	0.45
High-tech firm (target)	1,521	0.40	0.00	0.49	588	0.33	0.00	0.47
Enterprise value of transaction (mil)	1,521	2522.25	444.28	9583.32	588	1941.54	226.19	6838.77
Value of Transaction (mil)	1,521	2145.85	385.22	8329.79	588	1586.12	177.82	6013.43
Target EBITDA LTM (mil)	1,457	142.92	13.78	718.85	526	207.39	10.12	1602.82
Target Total Assets (mil)	1,503	1205.32	200.76	4359.60	555	1246.84	148.93	4199.13
Target Net Sales LTM (mil)	1,489	1113.10	193.75	3763.57	542	1012.73	124.34	3513.33
CA HQ (target)	1,521	0.28	0.00	0.45	588	0.21	0.00	0.41
NY HQ (target)	1,521	0.06	0.00	0.24	588	0.09	0.00	0.28
CA HQ (acq.)	1,521	0.24	0.00	0.43	588	0.16	0.00	0.37
NY HQ (acq.)	1,521	0.10	0.00	0.29	588	0.13	0.00	0.33

Internet Appendix for "Measuring Intangible Capital with Market Prices" (Ewens, Peters and Wang (2020))

IA1 Figures and tables

Figure IA1: Example of Purchase Accounting

Acquiring firm (A) acquires target firm (T) in an acquisition which closes on March 31, 2018. Book value of T's net assets ex-acquisition is 55. In the due diligence process, T's net assets are marked to market to a value of 95 following ASC 805. Identifiable intangible assets of 35 are revealed on A's balance sheet post-acquisition date. A agrees to purchase T by issuing stock with a fair market value of 150. Goodwill of 55 is recorded to A's balance sheet to represent the additional value paid by the acquirer over and above the fair value of all of T's identifiable net assets.

Target (T's) Balance Sheet as of December 31, 2017 (Pre-Acquisition)

Assets		Liabilities & Equity	
Cash	10	Current Liabilities	15
Receivables	10	Long-Term Debt	30
Inventories	20	Capital Stock	10
PP&E, net	60	Retained Earnings	45
T's Total Assets	100	T's Total Liabilities & Equity	100

Acquiror (A's) Balance Sheet as of December 31, 2017 (Pre-Acquisition)

Assets		Liabilities & Equity	
Cash	80	Current Liabilities	120
Receivables	120	Long-Term Debt	230
Inventories	100	Capital Stock	500
PP&E, net	700	Retained Earnings	150
A's Total Assets	1000	A's Total Liabilities & Equity	1000

On March 30, 2018, Acquiror Purchases Target for Fair Value Consideration in exchange for 10 shares of common stock

Target's Fair Market Value of Net Assets as of March 31, 2018 (Acquisition Date)

Cash	10
Receivables	10
Inventories	15
PP&E Net	70
Tangible Assets	105
IPR&D	20
Patents	10
Trademarks	5
Intangible Assets	35
Total Assets	140
Current Liabilities	15
Long-Term Debt	30
Total Liabilities	45
FV of Net Assets	95

Note that the purchase method results in identifiable intangible assets (IIA) of 35, and goodwill (GW) of 55.

Acquiror's entry to record transaction using purchase method on March 31, 2018

Cash	10	
Receivables	10	
Inventories	15	
PP&E Net	70	
IPR&D	20	
Patents	10	
Trademarks	5	
Goodwill	55	
Current Liabilities		15
Long-Term Debt		30
Capital Stock		150

Value assigned to goodwill is the difference between the fair value consideration of the acquiring firm and the target's fair value of net assets.

Goodwill = 150 - 95 = 55

Acquiror (A's) Balance Sheet as of April 1, 2018 (Post-Acquisition)

Assets		Liabilities & Equity	
Cash	90	Current Liabilities	135
Receivables	130	Long-Term Debt	260
Inventories	115	Capital Stock	650
PP&E, net	770	Retained Earnings	150
IPR&D	*20*		
Patents	*10*		
Trademarks	*5*		
Goodwill	*55*		
A's Total Assets	1195	A's Total Liabilities & Equity	1195

Figure IA2: Example of Pooling Accounting

Acquiring firm (A) acquires target firm (T) in an acquisition which closes on March 31, 2018. Book value of T's net assets ex-acquisition is 55. A agrees to purchase T by issuing shares of common stock. Contrary to the purchase method, fair market values of both A's net assets and T's common stock offering are ignored for accounting purposes. No goodwill or intangible assets are identified and brought to A's balance sheet. A's post-acquisition balance sheet represents only the net assets of T at book value.

Target (T's) Balance Sheet as of December 31, 2017 (Pre-Acquisition)

Assets		Liabilities & Equity	
Cash	10	Current Liabilities	15
Receivables	10	Long-Term Debt	30
Inventories	20	T's Capital Stock	10
PP&E, net	60	Retained Earnings	45
T's Total Assets	100	T's Total Liabilities & Equity	100

Acquiror (A's) Balance Sheet as of December 31, 2017 (Pre-Acquisition)

Assets		Liabilities & Equity	
Cash	80	Current Liabilities	120
Receivables	120	Long-Term Debt	230
Inventories	100	Capital Stock	500
PP&E, net	700	Retained Earnings	150
A's Total Assets	1000	A's Total Liabilities & Equity	1000

On March 30, 2018, Acquiror Purchases Target's Net Assets in exchange for 10 shares of A's common stock

Target's Book Value of Net Assets as of March 31, 2018 (Acquisition Date)

Cash	10
Receivables	10
Inventories	20
PP&E Net	60
T's Total Assets	100
Current Liabilities	15
Long-Term Debt	30
T's Total Liabilities	45
Net Assets	55

Note that in the pooling method, no mark-to-market occurs at the time of acquisition.

No goodwill is recognized, and intangible assets are not identified in the pooling method.

Acquiror's Entry to record transaction using pooling method on March 31, 2018

	Debit	Credit
Cash	10	
Receivables	10	
Inventories	20	
PP&E Net	60	
Current Liabilities		15
Long-Term Debt		30
A's Capital Stock		10
Retained Earnings		45

Acquiror (A's) Balance Sheet as of April 1, 2018 (Post Acquisition)

Assets		Liabilities & Equity	
Cash	90	Current Liabilities	135
Receivables	130	Long-Term Debt	260
Inventories	120	Capital Stock	510
PP&E, net	760	Retained Earnings	195
A's Total Assets	1100	A's Total Liabilities & Equity	1100

Note that in the pooling method, the balance sheet of acquiror and target are simply combined at book values.

Figure IA3: Example of goodwill accounting and negative goodwill

A credits-and-debits analysis of goodwill and negative goodwill.

Standard Case: **Goodwill** contains synergies, mark-to-market of assets is too conservative, or overpayment.

Fair Value of Assets of Acquirer (+A)	100		
Fair Value of Liabilities of Acquirer (-L)		50	
Cash (-A)		130	
*Goodwill (+A)	80		← (Goodwill to balance)

*Goodwill asset impaired over subsequent years, until is depleted.

Amortization of Goodwill (-E)	XX	
Goodwill (-A)		XX

Rare Case: Negative goodwill. May arise due to bargain purchase of target (e.g., distressed fire-sale), too conservative in mark-to-market of liabilities (or off-balance sheet liabilities exist),

Fair Value of Assets of Acquirer (+A)	100		
Fair Value of Liabilities of Acquirer (-L)		50	
Cash (-A)		30	
**Neg Goodwill-plug (-A)		20	← (Neg goodwill to balance)

**Immediate write-off of negative goodwill as extraordinary gain.

**Neg Goodwill-plug (-A)	20		
Extraordinary Gain		20	← (Recorded to I/S as one-time gain)

Figure IA4: Percentage of acquisition deal size for intangible assets: post-goodwill adjustment

The figure reports the average percentage of an acquisition deal size (i.e., enterprise value of the deal) attributed to goodwill after synergy or over-payment adjustment and its sum with IIA. The adjustment detailed in Section A2.2 uses the market reaction to the acquisition announcement for both the target and acquirer. The sample is the subset of acquisitions (see Section 3) associated with deals that have non-zero goodwill or intangible assets acquired.

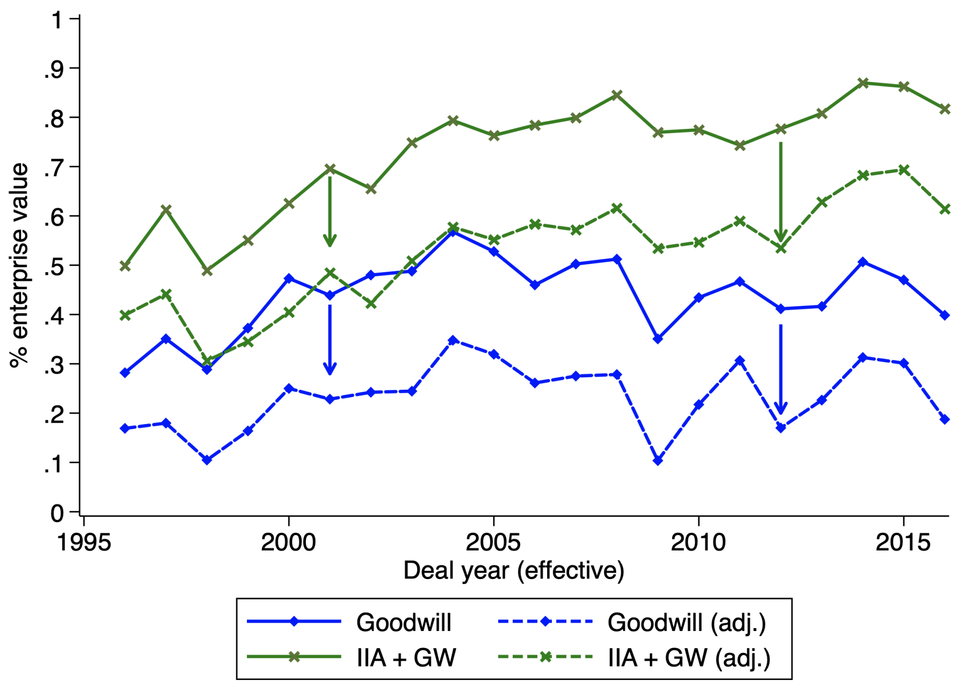


Figure IA5: Estimated year fixed effects and S&P 500 index

The figure reports the exponentiated year fixed effects ρ_t from the non-linear least squares estimation of equation (12):

$$\log(1 + P_{it}^I) = \log(\rho_t) + \log(I_{it} + \sum_{k=1}^{10}(1-\delta_G)^k \text{R\&D}_{i,t-k} + \sum_{k=1}^{10}(1-0.2)^k \gamma \text{SG\&A}_{i,t-k} + 1)$$

along with de-meaned, de-trended levels of the S&P 500 index at the end of the 2nd quarter of each year (dashed line). The year fixed effects are estimated in logs and constrained such that they average zero over all years.

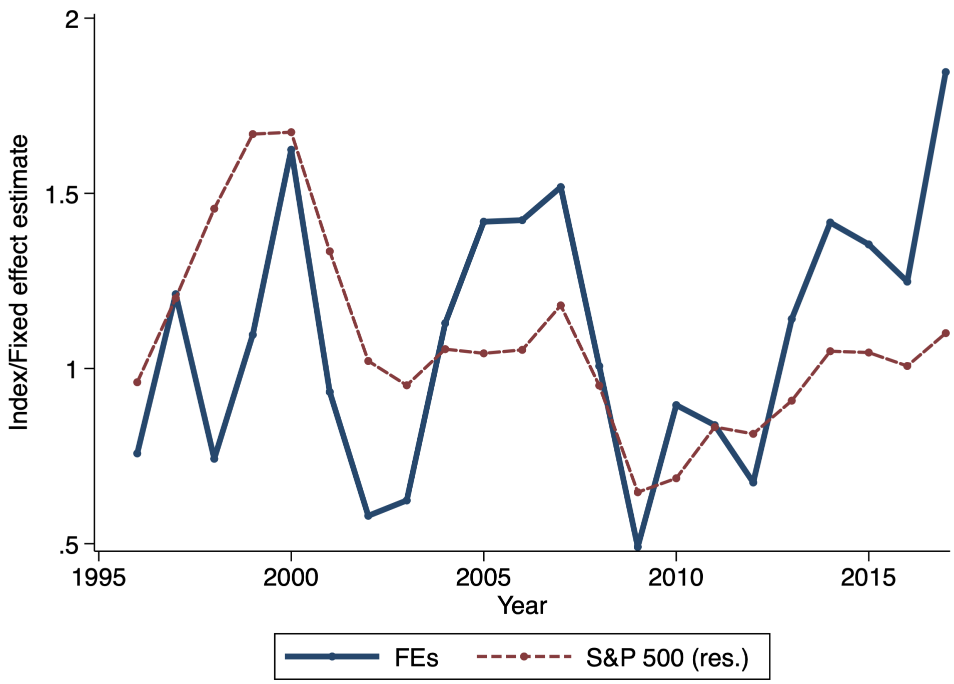


Table IA1: Eisfeldt and Papanikolau (2013), Table IA.I: Using the Ewens, Peters and Wang (2020) organizational stocks

The table repeats the analysis of Table IA.I in Eisfeldt and Papanikolaou (2013)'s Internet Appendix. The table reports the statistics of various firm observables in an unconditional annual sort using our new measure of organizational stocks.

Ewens, Peters and Wang

	Lo	2	3	4	Hi
	mean	mean	mean	mean	mean
Organization capital to book assets	0.04	0.09	0.18	0.31	0.81
Market capitalization (log)	6.48	6.60	6.36	5.85	5.10
Tobin's Q	1.13	1.32	1.36	1.34	1.66
Tobin's Q (scaled by PPE)	4.72	8.10	8.83	7.67	7.62
Total Q (Ewens, Peters and Wang (2018)	3.05	2.39	2.27	1.67	1.08
Total Q (Peters and Taylor (2017)	2.96	2.30	2.14	1.62	1.11
Sales to book assets (%)	68.56	84.76	104.96	122.20	144.70
Earnings to book assets (%)	7.22	7.80	7.94	6.35	-0.49
Advertising expenditures to book assets	1.09	1.60	2.52	3.68	6.37
Investment to capital (organization, %)	192.75	149.35	132.14	114.02	85.50
Investment to capital (physical, %)	17.83	15.79	15.32	14.66	14.46
Physical capital to book assets	64.80	61.33	50.47	41.14	42.62
Debt to book assets	33.38	29.18	25.21	20.83	16.54
Capital to labor (log)	4.83	4.58	4.21	3.96	3.74
Firm Solow Residual	-37.31	-9.16	8.78	19.60	14.09
	Lo	2	3	4	Hi
	mean	mean	mean	mean	mean
Executive compensation to book assets (%)	0.17	0.28	0.37	0.47	0.65
CEO turnover	0.18	0.16	0.18	0.18	0.20

Table IA2: OLS Results from an Investment-q Relation: By industry

Results are from OLS panel regressions of investment on lagged Tobin's q and firm and year fixed effects. A unit of observation is a firm-year for public firms from 1996–2016. We follow the Peters and Taylor (2017) method to construct both a new total capital that incorporates intangibles and a modified investment rate for *SG&A*. Each column uses a different investment measure noted in the top rows

$$I_{it} = \beta Q_{it} + \mu_i + \eta_t + \varepsilon_{it}$$

"Total Q (PT)" is the Q_{it} from Peters and Taylor (2017) that uses the BEA-HH depreciation rates. The row "Total Q (EPW)" presents an alternative total Q that uses the depreciation and investment fractions from Table 1 to calculate total intangible stock. Because our main parameters in Table 1 are estimated by industry, each panel here is an industry sub-sample. The "Within-R2" are the within-firm and -year R^2. Standard errors clustered at the firm-year reported in parentheses. Significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	R&D		SG&A		CAPX		CAPX+R&D+SG&A	
				Consumer				
Total Q (PT)	0.0016***		0.0075***		0.0079***		0.017***	
	(0.00034)		(0.00078)		(0.00093)		(0.0014)	
Total Q (EPW)		0.0018***		0.0071***		0.0083***		0.017***
		(0.00035)		(0.00071)		(0.00088)		(0.0012)
Observations	29435	29435	29442	29442	29462	29462	29435	29435
R^2	0.57	0.58	0.64	0.63	0.38	0.37	0.50	0.49
Within-R^2	0.047	0.048	0.13	0.16	0.077	0.084	0.16	0.18
				Manufacturing				
Total Q (PT)	0.0026***		0.0057***		0.0059***		0.014***	
	(0.00055)		(0.00077)		(0.0011)		(0.0018)	
Total Q (EPW)		0.0029***		0.0052***		0.0059***		0.014***
		(0.00057)		(0.00070)		(0.0010)		(0.0016)
Observations	18467	18467	18469	18469	18476	18476	18467	18467
R^2	0.56	0.62	0.59	0.57	0.30	0.29	0.43	0.44
Within-R^2	0.057	0.058	0.11	0.11	0.050	0.053	0.13	0.13
				High Tech				
Total Q (PT)	0.0046***		0.0060***		0.0071***		0.018***	
	(0.00035)		(0.00037)		(0.00052)		(0.0010)	
Total Q (EPW)		0.0050***		0.0069***		0.0071***		0.019***
		(0.00039)		(0.00044)		(0.00051)		(0.0011)
Observations	28783	28783	28784	28784	28795	28795	28783	28783
R^2	0.61	0.62	0.53	0.51	0.42	0.42	0.56	0.55
Within-R^2	0.12	0.13	0.17	0.15	0.17	0.16	0.29	0.27
				Healthcare				
Total Q (PT)	0.0060***		0.0060***		0.0048***		0.017***	
	(0.00070)		(0.00049)		(0.00070)		(0.0014)	
Total Q (EPW)		0.0072***		0.0057***		0.0042***		0.017***
		(0.00074)		(0.00069)		(0.00066)		(0.0015)
Observations	13519	13519	13519	13519	13524	13524	13519	13519
R^2	0.54	0.61	0.56	0.48	0.28	0.26	0.47	0.44
Within-R^2	0.066	0.077	0.14	0.078	0.077	0.068	0.18	0.16
Year / Firm FE	Y	Y	Y	Y	Y	Y	Y	Y

IA2 Real-world purchase price allocation examples

Matrix Pharmaceutical, February 20, 2002

Note 4 – Acquisition of Matrix Pharmaceutical, Inc.

On February 20, 2002, Chiron acquired Matrix Pharmaceutical, Inc. a company that was developing tezacitabine, a drug to treat cancer. As of March 31, 2002, Chiron acquired substantially all of the outstanding shares of common stock of Matrix Pharmaceutical at $2.21 per share, which, including estimated acquisition costs, resulted in a total preliminary purchase price of approximately $67.1 million. Matrix Pharmaceutical is part of Chiron's biopharmaceuticals segment. Tezacitabine expanded Chiron's portfolio of cancer therapeutics.

Chiron accounted for the acquisition as an asset purchase and included Matrix Pharmaceutical's operating results, including the seven business days in February 2002, in its consolidated operating results beginning on March 1, 2002. The components and allocation of the preliminary purchase price, based on their fair values, consisted of the following (in thousands):

Consideration and acquisition costs:		
Cash paid for common stock	$	49,986
Cash paid for options on common stock		1,971
Common stock tendered, not yet paid		8,751
Options on common stock, not yet paid		260
Acquisition costs paid as of March 31, 2002		3,323
Acquisition costs not yet paid as of March 31, 2002		2,796
Total purchase price	$	67,087
Allocation of preliminary purchase price:		
Cash and cash equivalents	$	17,337
Assets held for sale		2,300
Deferred tax asset		10,000
Other assets		1,469
Write-off of purchased in-process technologies		54,781
Accounts payable		(2,898)
Accrued liabilities		(15,902)
Total purchase price	$	67,087

Electronic Data Services, August 26, 2008

On August 26, 2008, HP completed its acquisition of EDS, a leading global technology services company, delivering a broad portfolio of information technology, applications and business process outsourcing services to clients in the manufacturing, financial services, healthcare, communications, energy, transportation, and consumer and retail industries and to governments around the world. The acquisition of EDS will strengthen HP's service offerings for information technology outsourcing, including data center services, workplace services, networking services and managed security; business process outsourcing, including health claims, financial processing, CRM and HR outsourcing; and applications, including development, modernization and management.

The total preliminary estimated purchase price for EDS was approximately $13.0 billion and was comprised of:

Acquisition of approximately 507 million shares of outstanding common stock of EDS at $25 per share in cash	$12,670
Estimated fair value of outstanding stock options and restricted stock units assumed	328
Estimated direct transaction costs	34
Total preliminary estimated purchase price	$13,032

In connection with the acquisition, HP assumed options to purchase approximately 8 million shares of HP's common stock at a weighted-average exercise price of approximately $50 per share. HP also assumed approximately 11 million restricted stock units with a weighted-average grant date fair value of $45. [...]

Direct transaction costs include investment banking, legal and accounting fees and other external costs directly related to the acquisition.

The purchase price allocations as of the date of the acquisition in the table below reflect various preliminary estimates and analyses, including preliminary work performed by third-party valuation specialists, and are subject to change during the purchase price allocation period (generally one year from the acquisition date) as valuations are finalized.

In millions	
Cash and short-term investments	$ 3,034
Accounts receivable	2,549
Property, plant and equipment	3,203
Other tangible assets	3,126
Notes payable and debt	(3,298)
Pension liability (Note 15)	(2,243)
Restructuring liability (Note 8)	(1,515)
Net deferred tax liabilities	(1,427)
Other liabilities assumed	(5,370)
Total net tangible liabilities	$ (1,941)
Amortizable intangible assets:	
Customer contracts and related relationships	3,199
Developed technology and trade name	1,349
Goodwill	10,395
IPR&D	30
Total preliminary estimated purchase price	$13,032

J. Jill, May 3, 2006

4. ACQUISITION OF J. JILL

On May 3, 2006, the Company acquired J. Jill, a multi-channel specialty retailer of women's apparel. J. Jill markets its products through retail stores, catalogs, and online. As of May 3, 2006, J. Jill operated 205 stores in the United States. J. Jill circulated approximately 56 million catalogs during 2005. The Company believes that the acquisition of J. Jill will provide the Company with a long-term growth vehicle and an opportunity to maximize the cost synergies of J. Jill and Talbots similar business models, particularly in back office functions. Both J. Jill and Talbots serve the 35 plus customer population; J. Jill focusing on apparel for a sophisticated casual lifestyle, with artistically inspired styles, providing a counterpoint to Talbots offering of updated modern classics.

Talbots acquired all of the outstanding shares of J. Jill for $24.05 per share for total consideration of $518,320 in cash. The Company used the proceeds from its $400,000 loan facility (see Note 9), as well as cash on hand to fund the acquisition. The Company also incurred acquisition-related fees and expenses of $5,967. The acquisition has been accounted for as a purchase in accordance with Statement of Financial Accounting Standards ("SFAS") No. 141, *Business Combinations* ("SFAS No. 141"), and accordingly, the results of operations of J. Jill have been included in the accompanying condensed consolidated statements of operations for the thirteen and twenty-six weeks ended July 29, 2006 from the date of the acquisition. In accordance with SFAS No. 141, the total purchase price has been preliminarily allocated to the tangible and intangible assets and liabilities acquired based on management's estimates of current fair values and may change as appraisals are finalized and as additional information becomes available. The resulting goodwill and other intangible assets will be accounted for under SFAS No. 142, *Goodwill and Other Intangible Assets* ("SFAS No. 142"). The following table summarizes the preliminary estimated fair values of the assets acquired and liabilities assumed, at the date of the acquisition, for an aggregate purchase price of $524,287, including acquisition costs.

	As of May 3, 2006
Cash	$ 30,445
Other current assets	109,842
Property and equipment	154,553
Goodwill	221,171
Trademarks	80,000
Other intangible assets	93,152
Current liabilities	(55,266)
Deferred income taxes	(98,224)
Other long-term liabilities	(11,386)
Total	$ 524,287

As part of the purchase price allocation, all intangible assets were preliminarily identified and valued. Of the total purchase price, $80,000 was assigned to trademarks, and $93,152 was assigned to other intangible assets, which consist of customer relationships of $77,700, non-compete agreements of $4,500, and favorable leasehold interests of $10,952. Management is in the process of finalizing the valuation of the acquired J. Jill intangibles. The amortization of the intangible assets that are subject to amortization is expected to be recognized over a weighted average life of approximately 11 years.

The acquired trademarks have been assigned an indefinite life and will not be amortized. Trademarks will be reviewed for impairment or for indicators of a limited useful life on an annual basis or when events indicate that the asset may be impaired.

The amount assigned to customer relationships, $77,700, is being amortized using a method that reflects the pattern in which the economic benefits of the intangible asset are expected to be consumed over a weighted average life of approximately twelve years. The amount assigned to non-compete agreements, $4,500, is being amortized on a straight-line basis over the period that the agreements are enforceable, approximately twenty months. The amount assigned to favorable leasehold interests, $10,952, is being amortized on a straight-line basis over the remaining lease period, or a weighted average of approximately eight years.

The excess of the purchase price over the fair value of tangible and identifiable intangible net assets was allocated to goodwill, which is non-deductible for tax purposes and preliminarily is estimated to be $221,171. In accordance with SFAS No. 142, this amount will not be amortized. Goodwill will be reviewed for impairment on an annual basis or when events indicate that the asset may be impaired.

R.R. Donnelley & Sons acquires Edgar Online, May 3, 2006[58]

On August 14, 2012, the Company acquired EDGAR Online, a leading provider of disclosure management services, financial data and enterprise risk analytics software and solutions. The acquisition of EDGAR Online will expand and enhance the range of services that the Company offers to its customers. The purchase price for EDGAR Online was $71.5 million, including debt assumed of $1.4 million and net of cash acquired of $2.1 million. Immediately following the acquisition, the Company repaid the $1.4 million of debt assumed. EDGAR Online's operations are included in the U.S. Print and Related Services segment.

[...]

The XPO and EDGAR Online acquisitions were recorded by allocating the cost of the acquisitions to the assets acquired, including intangible assets, based on their estimated fair values at the acquisition date. The excess of the cost of the acquisitions and the fair value of the contingent consideration over the net amounts assigned to the fair value of the assets acquired was recorded as goodwill. The preliminary tax deductible goodwill related to these acquisitions was $12.3 million. [...] Based on the current valuations, the purchase price allocations for these acquisitions were as follows:

[58] https://www.sec.gov/Archives/edgar/data/29669/000119312512446613/d416826d10q.htm

Accounts receivable	$ 15.4
Prepaid expenses and other current assets	0.8
Property, plant and equipment	2.2
Amortizable other intangible assets	24.2
Other noncurrent assets	14.0
Goodwill	44.4
Accounts payable and accrued liabilities	(16.3)
Other noncurrent liabilities	(0.1)
Deferred taxes-net	10.4
Total purchase price-net of cash acquired	95.0
Less: debt assumed	1.4
Less: fair value of contingent consideration	3.5
Net cash paid	$ 90.1

The fair values of technology, amortizable intangible assets, contingent consideration and goodwill associated with the acquisitions of XPO and EDGAR Online were determined to be Level 3 under the fair value hierarchy. The following table presents the fair value, valuation techniques and related unobservable inputs for these Level 3 measurements:

	Fair Value	Valuation Technique	Unobservable Input	Range
Customer relationships	$ 20.2	Excess earnings, with and without method	Discount rate Attrition rate	16.0% - 17.5% 7.0% - 20.0%
Technology	13.4	Excess earnings, relief-from-royalty method, cost approach	Discount rate Obsolescence factor Royalty rate (after-tax)	16.0% - 17.0% 10.0% - 20.0% 4.5%
Trade names	3.1	Relief-from-royalty method	Discount rate Royalty rate (after-tax)	15.5% - 17.5% 0.5% - 1.2%
Non-compete agreements	0.9	With and without method	Discount rate	17.5%
Contingent consideration	3.5	Probability weighted discounted future cash flows	Discount rate	4.5%