Value of Internally Generated Intangible Capital

Aneel Iqbal
Doctoral Candidate
Haskayne School of Business, University of Calgary
aneel.iqbal1@ucalgary.ca

Shivaram Rajgopal
Roy Bernard Kester and T.W. Byrnes Professor of Accounting and Auditing
Columbia Business School, Columbia University
sr3269@columbia.edu

Anup Srivastava
Canada Research Chair
Haskayne School of Business, University of Calgary
anup.srivastava@ucalgary.ca

Rong Zhao
Associate Professor
Haskayne School of Business, University of Calgary
rozhao@ucalgary.ca

ABSTRACT:

Based on the current U.S. GAAP, internally developed intangibles are not included in reported assets. Omission of an increasingly important class of assets reduces the usefulness and relevance of financial statement analysis, conducted using book value. Recent studies attempt to overcome this deficiency by capitalizing the outlays reported in selling, general, and administrative (SG&A) expenses and reestimating book values with capitalized intangibles, using a perpetual inventory model. However, those studies rely on one-size-fits-all mechanical rules of thumb, such as treating a uniform 30% of SG&A as investments and assuming the same life of SG&A investments across all industries. We propose a new method to estimate the industry-specific capitalization and amortization rates for research and development and SG&A outlays. Our modified book value exhibits greater association with future risk-adjusted returns, future investments, and bankruptcy probability as per the Altman Z-score model, relative to both as-reported book values and the mechanically adjusted book values. We contribute to the literature by proposing a new method for estimating intangible investments and by providing a better estimate of book value that can be used by consumers of financial statements.

Keywords: Intangibles, Book Value, Financial Statement Analysis, Valuation

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1. Introduction

That a firm's in-house intangible investments create future value, on average, is well established.[1] U.S. Generally Accepted Accounting Principles (GAAP) require such investments to be expensed as incurred, given the uncertainty of their payoffs. The GAAP treatment of intangibles is unlike that of expenditures on property, plant, and equipment (PP&E) and acquired intangibles, under the purchase accounting method for acquisitions, that are capitalized and reported on balance sheets as assets. Omission of an important class of assets reduces the usefulness and relevance of financial statement analysis, conducted using book value. For example, the calculations of residual income and its valuation model and ratios such as Tobin's Q, market-to-book, return on capital, asset turnover, debt-to-equity, and asset coverage require a reliable estimate of book value. Meanwhile, the importance of intangibles in the U.S. economy keeps increasing, as each new crop of public firms spends more on intangibles than its predecessor cohort (Corrado, Hulten, and Sichel 2005; Srivastava 2014).

Recent studies attempt to overcome this deficiency in financial reports, that is, the omission of in-house intangible investments in reported assets, by capitalizing the outlays reported in selling, general, and administrative (SG&A) expenses (e.g., Peters and Taylor 2017; Hulten and Hao 2008; Falato, Kadyrzhanova, Sim, and Steri 2020; Eisfeldt, Kim, and Papanikolaou 2020). However, those studies rely on one-size-fits-all mechanical rules of thumb, such as treating a uniform 30% or 50% or even 100% of SG&A as investments, irrespective of the firm's industry affiliation or its business model. Compounding this one-size-fits-all capitalization assumption [how much of

[1] See, for example, Aboody and Lev (1998), Lev and Sougiannis (1996), Kothari, Laguerre, and Leone (2002), Enache and Srivastava and (2018), and Banker, Huang, Natarajan, and Zhao (2019).

research and development (R&D) and SG&A to capitalize] is another assumption: that the period over which capitalized assets should be amortized is the same across all firms. These two assumptions are critical to reestimating book values with capitalized intangibles, using a perpetual inventory model.

We propose a new method to estimate the industry-specific capitalization and amortization rates for R&D and SG&A outlays. We begin by documenting significant variation in those two rates across industries, casting doubt on the assumption of uniform capitalization and amortization rates. We test the usefulness of our refined methods by showing that our modified book value exhibits greater association with future risk-adjusted returns (Fama and French 1992), future investments, and bankruptcy probability as per the Altman Z-score model (Altman 1968), relative to both as-reported book values and the mechanically adjusted book values as per Peters and Taylor (2017). In essence, we contribute to the literature by proposing a new method for estimating intangible investments and by providing a better estimate of book value that can be used by consumers of financial statements.

SG&A includes R&D and expenditures on process improvement, information technology, organizational strategy, hiring and training personnel, customer acquisition, and brand development, as well as spending aimed at wringing efficiencies from firms' peer and supplier networks that produce future benefits (Eisfeldt and Papanikolaou 2014; Falato et al. 2020; Peters and Taylor 2017). A growing body of literature reconstructs book values for value investing and financial statement analysis by capitalizing SG&A expenses. For example, Peters and Taylor (2017) assume that all firms spend 30% of their MainSG&A (SG&A less R&D) on future investments, regardless of whether these firms are in diverse industries such as food and restaurant, pharmaceutical, or electronics. Numerous recent studies follow such mechanical approach.[2] In addition, prior studies do not distinguish between "maintenance" R&D and "investment" R&D, with maintenance R&D referring to outlays that improve products and processes for just the current period, not in the distant future. This assumption is also contrary to the tenet in International Accounting Standard (IAS) 38, the International Financial Reporting Standards (IFRS) Foundation requirement that firms distinguish between investment and maintenance R&D.[3]

At least two recent studies take the additional step of measuring the investment portion in SG&A depending on the context. Lev and Srivastava (2019) identify the firm-year specific investment portion of MainSG&A to improve HML (high minus low) factor-based value investing. They rely on a method proposed by Enache and Srivastava (2018), which suggests that the portion of MainSG&A matched to current revenues is likely to be a maintenance expense. Enache and Srivastava assume that the unmatched portion of MainSG&A is an investment, given that the firms invest rationally (Fisher 1930; March 1991; Mizik and Jacobson 2003). Yet, Enache and Srivastava acknowledge that the unmatched portion could include sticky costs, real earnings management, and wasteful expenditures such as managerial empire building. Furthermore, a few ex-ante profitable investments may ex post turn out to be unproductive and should not be capitalized.

Ewens, Peters, and Wang (2020) propose a novel method that relies on market prices of intangibles to estimate the two key parameters required for intangible-capital accumulation process: industry-specific R&D depreciation rates and investment portion of SG&A. Market prices however come from a limited set of events (acquisitions, bankruptcies, and liquidations), which are not applicable for a majority of firms that invest in in-house intangibles for use within the firm

[2] See, for example, Eisfeldt, Kim, and Papanikolaou (2020), Arnott, Harvey, Kalesnik, and Linnainmaa (2021), Li (2021), and Choi, So, and Wang (2021).
[3] Under IAS 38, research costs are expensed, and development expenditures are capitalized when certain criteria are met.

(Li and Hall 2020). Moreover, the allocation of purchase prices between identifiable tangible and intangible assets of acquired companies, and the residual amount towards goodwill, is arguably unreliable and somewhat arbitrary. On top of that, Lev and Srivastava (2019) and Ewens et al. (2020) assume that the useful lives, and therefore the amortization schedules, for SG&As are uniform across industries. Ewens et al. (2020) also consider 100% of R&D expenditures to be an investment outlay.

We contribute to the extant literature by improving the estimation of investment proportions and useful lives of R&D and MainSG&A. We estimate two regressions, one with R&D as the dependent variable and the other with MainSG&A, on current revenues and a series of future revenues, with all variables scaled by average total assets. The focus on future revenues implicitly leads to the inclusion of R&D and MainSG&A expenditures that produce future benefits and exclusion of those that turn out to be unproductive, ex post. Ideally, from a financial statement user perspective, the former should be capitalized and included in the assets, and the latter should not be.[4] A better identification of either category of expenses should lead to better estimates of book value than a method based on mechanical rules of thumb. For R&D (MainSG&A), we estimate seven (five) such regressions on an industry basis, wherein we assume that R&D (MainSG&A) yields future benefits for a period ranging from zero to seven (five) years of future revenues in the regression. In both cases, we identify the equations that provide the highest adjusted *R*-squared values of regressing R&D or MainS&GA on future years' revenues for each industry.

This idea of associating current expenditure with future economic benefits has been used in prior studies (e.g., Lev and Sougiannis 1996; Banker, Huang, Natarajan, and Zhao 2019). Those

[4] Any inclusion of an outlay in assets that ex post turns out to be unproductive would lead to a write-off and asset impairment.

studies regress future operating earnings on lagged values of either SG&A or R&D (technically referred to as unrestricted finite distributed lag model). We make two modifications to those models. First, we use expenditures as the dependent variable (and not as an independent variable, as in prior studies). Second, we use future revenues as the outcome variables (and not the operating income, used in prior studies). These modifications enable us to identify the optimal lag structure by industry, that is, the model that shows the best association of current expenditures with future revenues. Our method simultaneously identifies the investment portions and the useful lives of intangible expenditures. The investment portion is the part of intangible expenditures associated with future revenues, and useful life is the optimal number of future revenues that maximizes the adjusted *R*-squared of the equation estimated.

We find that the investment portions of R&D and MainSG&A differ dramatically across industries. For example, investment portions of R&D for pharmaceutical products, medical equipment, and computers are 92%, 89%, and 74%, respectively. Thus, it is not 100% even for the most innovative industries. For extractive industries such as metal mining and oil, the investment portions in MainSG&A are as high as 78% and 73%, respectively, because their MainSG&A includes exploration and dry-hole expenses. Similarly, for pharmaceutical products and medical equipment, the investment portions in MainSG&A are 73% and 71%, respectively. For most industries, the investment portion is less than 50%. For instance, the investment portion is less than 5% for business supplies and transportation industries, indicating that most of their MainSG&A supports current, not future, operations. These findings cast doubt on a critical assumption in the prior studies that the investment portions of intangible expenditures are uniform across firms.

We find that the useful lives for R&D and MainSG&A also differ across industries, averaging 5.08 and 2.73 years, respectively. For example, for R&D, useful life varies from zero years for the recreation industry (that is, R&D is not associated with future revenues) to seven years for pharmaceutical industries. For MainSG&A, useful life ranges from zero for textiles to five years for communications. This result raises questions about the second main assumption used in prior studies: that the amortization schedules of intangible investments are uniform across industries. More important, the useful lives of MainSG&A are shorter than considered in prior literature, which is typically five years for studies assuming a 20% amortization rate (Falato et al. 2020; Peters and Taylor 2017). Thus, our estimates lower the amounts of capitalized MainSG&A intangibles.

Having estimated the investment portions of R&D and MainSG&A and their amortization schedules, we compute the capitalized values of intangibles using a perpetual inventory method. We add the capitalized values to reported values to recalculate what we call the modified book values of equity. Book values increase in all the cases, but the increase varies across industries, from just 2% to as much as 112%. The market-to-modified book ratio thus calculated with new book values falls relative to the as-reported values and converges closer to one, on average. The market-to-modified book ratio displays lower intra-industry variation, which can be interpreted as a relatively greater similarity in growth prospects of industry firms after considering the role of intangibles.

Finally, we investigate the validity of our method by conducting three tests. Our first test examines the association between our modified book-to-market ratio and future risk-adjusted returns (Fama and French 1992, 1993, 2005; Lakonishok, Schleifer, and Vishny 1994; Arnott, Harvey, Kalesnik and Linnainmaa 2021). We find that our modified book-to-market ratio outperforms the one based on as-reported numbers as well as the one based on uniform capitalization and amortization of R&D and MainSG&A. Results are stronger for intangible-intensive industries, such as high-tech and health-tech, than other industries, consistent with expectations.

Our second test follows Peters and Taylor (2017) and examines whether recalculated Tobin's Q better predicts future investments than the one calculated with as-reported book values. Tobin's Q proposed by Peters and Taylor has become a commonly used variable in empirical accounting, finance, and economics studies, indicating significant academic and practitioner demand for a more accurate Q. Our recalculated Tobin's Q outperforms both the Peters and Taylor (2017) Tobin's Q and the one calculated with as-reported book values in predicting future investments (measured as the sum of capital expenditures and intangibles, inclusive of investment portions of R&D and SG&A). In the third test, Altman's Z-score calculated using our modified book values and retained earnings better predicts bankruptcy for manufacturing industries than the analogous score based on reported numbers and mechanical capitalization.

We contribute to two streams of literature with this paper. First, we provide a new method for estimating intangible investments and the value of internally generated intangible capital. Our inductive approach must benefit those users of financial statements that currently reconstruct book values using a mechanical approach. Demand is growing for improved estimates of book values because of the omission of an important class of assets, evident by the numerous recent papers, particularly those that address the 21st-century failure of factor-based value investing (Lev and Srivastava 2019; Eisfeldt et al. 2020; Arnott, et al. 2021; Li 2021; Choi et al. 2021). Any method that improves the identification of expenditures that produce future benefits, and thus must be capitalized, and those that do not produce future benefits, and should not be capitalized, would arguably lead to better book value estimates than a mechanical rule of thumb. Second, we contribute to the ongoing debate in the literature about the capitalization of internally generated intangibles. Our study shows that the capitalized values are more useful for predicting future outcomes such as risk-adjusted returns and investments relative to extant methods used by the literature. Yet, we concede that we do not examine the full policy impact that such capitalization can have on the reliability of financial reports. We have not conducted any comprehensive welfare analysis of the policy of mandating capitalization, which is beyond the scope of this paper.

The remainder of the paper is organized as follows. Section 2 summarizes the prior literature and motivation for the research, Section 3 explains the measurement of intangible investments, Section 4 describes the measurement of modified book value, Section 5 details the empirical tests, and Section 6 concludes.

2. Prior Literature

In this section, we discuss prior literature on intangible capital and explain the reasons for proposing a new method for the measurement of value of internally generated intangibles.

2.1 Increasing importance of intangible capital

By the outset of the 21st century, the United States had moved from an industrial economy to a mainly knowledge-based economy (Baumol and Schramm, 2010; Shapiro and Varian, 1998). U.S. firms increased their investments in intangible capital such as innovation, advertising, information technology, human capital, and customer relations. Consistent with this trend, a dramatic increase took place over time in U.S. firms' average intangible intensity as measured by R&D expenses, market-to-book ratios, and SG&A expenses (Francis and Schipper 1999; Banker, Huang, and Natarajan 2011; Eisfeldt and Papanikolaou 2013). Srivastava (2014) shows that each newer generation of listed firms spends a higher percentage of outlays on intangibles than its predecessor. Corrado and Hulten (2010) show that intangible investments now exceed tangible investments in the U.S. economy.

U.S. GAAP requires that expenditures on internally generated intangibles be immediately expensed. The same GAAP rules permit firms to capitalize expenditures on PP&E and acquired intangibles. This difference is arguably based on the idea that payoffs from in-house intangible investments are more uncertain than the investments on tangible assets and acquired intangibles (Kothari, Laguerre, and Leone 2002). This one-size-fits-all rule of expensing internally generated intangibles has not been updated to account for the new economic reality that intangibles have become major value drivers for modern businesses (Corrado and Hulten 2005; Lev 2018). Many practitioners consequently contend that the growing omission of intangible assets hampers the relevance of financial statements because "accounting is no longer counting what counts" (Stewart 2002, p.1). Consistent with this view, studies show that the deficient accounting for internally generated intangibles adversely affects the informativeness of reported numbers to external users (Amir and Lev 1996; Lev and Zarowin 1996; Lev 1997). Further, this deficiency cannot be overcome even by sophisticated investors and financial analysts and results in systematic mispricing of securities for intangible-intensive firms (Aboody and Lev 2020; Lev and Gu 2016; Eberhart, Maxwell, and Siddique 2004). Arguably for this reason, Statement of Financial Accounting Standards (SFAS) No. 2, which mandates expensing of R&D, is associated with the highest loss in shareholder value among all accounting standards (Khan, Li, Rajgopal, and Venkatachalam 2018).

Given that accounting rules on internally generated intangibles are under consideration and likely to be so for long, on account of the lengthy comment period and drafting process that accounting regulators must follow, researchers have relied on statistical models to estimate the value of intangibles. Earlier research mainly focused on using R&D as a proxy for knowledge capital. Studies such as Lev and Sougiannis (1996) and Chan, Lakonishok, and Sougiannis (2001) capitalize R&D expenses and examine whether stock prices fully value firms' R&D capital. More recent studies examine SG&A, which includes R&D, for capitalization. Hence, recent studies consider two types of intangible investments to capitalize and label them as knowledge capital (capitalized R&D) and organizational capital (capitalized SG&A).

2.2 Prior literature on measuring the value of internally generated intangibles

Numerous studies measure knowledge and organizational capital using the perpetual inventory model. Two key aspects related to estimating this model are how much of the in-house intangible expenditures should be capitalized and how those capitalized in-house intangibles should be amortized.

Regarding the first aspect, the conventional practice is to capitalize the full amount of R&D expenses. For capitalizing SG&A or MainSG&A, no consensus exists. Studies typically capitalize a fixed and heuristic portion of SG&A expenses across all firms. For example, Peters and Taylor (2017) use 30%, and Eisfeldt and Papanikolaou (2013) and Falato et al. (2020) use 100%.[5]

While Main SG&A includes intangible investments, it also includes expenditures that support the current operations [consider head office and warehouse rents, customer delivery costs, and sales commissions (Matějka 2012)]. Enache and Srivastava (2018) argue that the maintenance and investment portions of MainSG&A could differ by industries. They identify maintenance portion in an industry-based regression as the portion matched to current revenues. They show that the remaining portion of MainSG&A behaves like an investment because it is associated with future profits, stock returns, and earnings volatility. They demonstrate that the investment portion of MainSG&A differs across industries. Nevertheless, Enache and Srivastava (2018) acknowledge

[5] Peters and Taylor (2017) vary the portion from zero to 100% and identify 30% as the one that maximizes their objective function, that is, Tobin's Q explaining future investments. They do not consider the possibility that the portion could vary across industries and over time.

that their measure of investment portion could include wasteful expenditures that do not produce intangible capital.

The idea for decomposing R&D into a maintenance and investment component comes from recent academic and practitioner literature. Govindarajan, Rajgopal, Srivastava, and Enache (2019) claim that R&D includes expenditures such as process improvement, engineering, third-party software, security and data integrity systems, customer monitoring, and digital content for day-to-day operations. Many of those expenditures benefit just the current period and should be considered operating expenses. The Govindarajan et al. (2019) argument is consistent with IFRS requiring firms to distinguish between maintenance and investment portions of R&D. Similarly, Curtis, McVay, and Toynbee (2020) show that the inclusion of maintenance outlays in R&D reduces R&D's association with future revenues.

The second aspect relates to the amortization rates of in-house intangible capital. Most studies adopt a simple and uniform structure for the productive lives of intangible capitals. A common rule of thumb is that the value of R&D capital declines by 20% a year (Chan et al. 2001; Falato et al. 2020; Peters and Taylor 2017). Lev and Sougiannis (1996) differ in that they consider industry-specific productive lives of R&D. The idea that R&D depreciation rates vary across industries has been used in Li (2012) and Li and Hall (2020). However, their analysis based on Bureau of Economic Analysis (BEA) data covers only a few, select industries, representing less than a third of firm-year observations in Compustat. For all other industries, prior studies typically assume a common R&D depreciation rate (e.g., 15%).

We are not aware of any study that estimates the useful lives of SG&A. Various heuristic depreciation rates have been used in prior literature: 15% in Eisfeldt and Papanikolaou (2013) and

Li, Qiu, and Shen (2018) and 20% in Falato et al. (2020), and Peters and Taylor (2017).[6] These studies thus assume a useful life of five to seven years for SG&A, similar to R&D.

3. Improving the Measurement of Internally Generated Intangible Capital

Our proposed methodology improves upon the two key aspects related to the measure of internally generated intangibles: the portion of in-house intangibles (MainSG&A or R&D) that should be capitalized (referred to as the investment portions) and its productive life. We estimate the following regression, by industry:

$$MainSG\&A_{i,t} \text{ or } R\&D_{i,t} = \alpha + \beta_0 \times Revenues_{i,t} + \sum_{k=1}^{n} \beta_k \times Revenues_{i,t+k} + e_{i,t}, \qquad (1)$$

where *i* denotes the firm and *t* denotes the year. Industry is represented by Fama-French 48 industry classification. α, β_0, and β_k are industry-specific estimates. We scale *MainSG&A*, *R&D*, and *Revenues* by the average of the beginning and the ending total assets for the year.[7] We include up to seven years of future revenues in equation (1) when *R&D* is the dependent variable and up to five years of future revenues when *MainSG&A* is the dependent variable. We require a minimum of 20 observations per industry. To estimate equation (1) for *MainSG&A* (*R&D*), we use only observations with nonzero *MainSG&A* (*R&D*).[8]

For each industry, we select the model that gives the highest adjusted *R*-squared.[9] We seek to identify the best model that incorporates an association between intangible expenditures and future benefits, with benefits proxied by revenues. We consider β_0 × *Revenues* as the maintenance

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[6] Some of these studies vary the depreciation rates to check the robustness of their results. They do not offer a definitive recommendation on which depreciation rates should be applied.

[7] We winsorize all regression variables at the 1st and 99th percentile.

[8] We do not have sufficient number of nonzero R&D observations for Fama-French industry 3 (candy and soda) and industry 27 (precious metals). Thus, these two industries are omitted.

[9] Our model differs from Lev and Sougiannis (1996) and Banker et al. (2019), who use an unrestricted finite distributed lag model. Both studies consider future operating earnings as the outcome variable, while we consider future revenues as the outcome variable. Both studies regress operating earnings on a series of lagged SG&A or R&D, while we regress MainSG&A and R&D on future revenues. This switch of left- and right-side variables enables us to identify the portion of MainSG&A and R&D associated with future revenues. Our model differs from Enache and Srivastava (2018) because we include future revenues in the model.

portion. We consider $\alpha + \sum_{k=1}^{n} \beta_k \times Revenues_{i,t+k}$ as the investment portion. The product of regression coefficients and future revenues is the portion of expenditure associated directly with future revenues. We include an intercept in the investment portion, consistent with Enache and Srivastava (2018) because it represents the industry-wide investments required to stay competitive. The number of years of future revenues included for each industry in the highest adjusted *R*-squared model denotes the useful lives of R&D and MainSG&A. We then use the straight-line depreciation method to calculate industry-specific depreciation rates for MainSG&A or R&D. (The rate is 1/optimal lag.)

Table 1 summarizes our sample selection. We start with Compustat and exclude observations with missing values for intangible capital stock provided by Peters and Taylor (2017) in Wharton Research Data Services (WRDS), to maintain valid comparisons with their method. We use Fama-French 48 industry classification and exclude observations with missing Standard Industrial Classification (SIC) codes, finance firms (Fama-French industries 44, 45, 46, and 47), utilities (Fama-French industry 31), and firms in the “almost nothing” category (Fama-French industry 48), similar to Enache and Srivastava (2018). We also exclude firms with missing book value of assets, sales, number of shares outstanding, book value of equity, capital expenditure, earnings per share, net income, and firms with less than $1 of stock price per share. Finally, we exclude observations that lack data on future sales revenue for up to seven years and assets from one year before to seven years after. We then restrict our analysis to 1975–2018, because SFAS 2 became effective in 1975 and the reporting of R&D spending prior to 1975 is inconsistent. These exclusions result in a preliminary sample of 140,183 firm-year observations from 13,649 firms. Sample sizes for additional tests vary based on additional data requirements.[10]

[Insert Table 1 near here]

Panel A of Table 2 presents the characteristics of our sample firms, and Panel B reports estimation results on the average investment portions and the productive lives of MainSG&A and R&D for each of the Fama-French 48 industries, calculated using equation (1).[11] They are called $UsefulLife_{R\&D}$ and $UsefulLife_{MainSG\&A}$, respectively. For the R&D model, we exclude the precious metals industry and the candy and soda industry because neither has enough observations with non-missing R&D.

[Insert Table 2 near here]

Panel B shows that the investment portions of MainSG&A and R&D vary widely across industries and differ significantly from the 30% and 100% values assumed in the prior literature. The highest proportion of investment MainSG&A is found in extractive industries: 78% for non-metallic and industrial metal mining and 73% for petroleum and natural gas, arguably because their exploration and dry-hole expenses are included in SG&A. For wholesale, medical equipment, and pharmaceutical industries, the investment portion exceeds 70%, which is likely to represent brand building, marketing, customer acquisition, and development of organizational competence. It is less than 10% for business supplies and transportation industries, sectors that do not spend much on intangibles. The investment portions of R&D for pharmaceutical products and medical equipment are the highest at 92% and 89%, respectively, which is consistent with intuition. These

[10] For tests related to the association between investments and Tobin's Q, we further exclude observations with less than $5 million in physical capital, following Peters and Taylor (2017). For tests related to bankruptcy prediction, we require non-missing values of Altman Z-scores.
[11] We sort the Fama-French 48 industries by the average market-to-book ratio.

industries compete with product innovation. For most other industries, the investment component ranges from 70% to 85%.

Productive lives of in-house intangibles for each industry are also presented in Panel B. For MainSG&A (R&D). Note that this value is restricted to five (seven) years by construction. Consistent with Lev and Sougiannis (1996), many industries are associated with R&D's productive life of seven years, such as pharmaceutical products, medical equipment, business services, electronic equipment, and electrical equipment. Nevertheless, other industries such as wholesale and recreation are associated with shorter productive lives of zero to three years. Similarly, we find a wide variation of productive lives for MainSG&A, from zero to five years. The weighted average of 2.78 years is significantly lower than the studies that consider an amortization rate of 15% to 20%.

The key takeaway from this section is that at least based on our model, the percentage of investment in R&D or MainSG&A and their useful lives cannot be assumed to be homogenous across all industries. We use the average industry percentages for all further calculation, calling them $IndustryInvestmentPercentage_{R\&D}$ and $IndustryInvestmentPercentage_{MainSG\&A}$, respectively. Thus, investment portion of R&D (MainSG&A), that is $Investment\_R\&D_{i,t}$ ($Investment\_MainSG\&A_{i,t}$) for a firm *i* in yeat *t* year is calculated by multiplying $IndustryInvestmentPercentage_{R\&D}$ ($IndustryInvestmentPercentage_{MainSG\&A}$) to its R&D (MainSG&A). Our results also show that the contribution of MainSG&A to intangible capital may be less long-lived than considered in prior studies. Thus, our estimation of the stock of intangible capital could be lower than previously considered.

4. Estimating the Value of Intangible Investments and Modified Book Values

We define the stock of internally created intangible capital as the sum of knowledge capital and organization capital, represented by unamortized values of investments in R&D and MainSG&A, respectively.

$$Intan\_Cap_{i,t}^{mod} = K_{i,t} + O_{i,t}, \tag{2}$$

where $K_{i,t}$ and $O_{i,t}$ represent the stock of internally created knowledge capital and organizational capital calculated using the perpetual inventory method:

$$K_{i,t} = (1 - \delta_{Ind,R\&D}) \times K_{i,t-1} + Investment\_R\&D_{i,t} \tag{3}$$

and

$$O_{i,t} = (1 - \delta_{Ind,SG\&A}) \times O_{i,t-1} + Investment\_MainSG\&A_{i,t}, \tag{4}$$

where $\delta_{Ind,R\&D}$ ($\delta_{Ind,SG\&A}$) represent the industry-specific amortization rate of investment portions of R&D (MainSG&A), calculated as $1/UsefulLife_{R\&D}$ ($1/UsefulLife_{MainSG\&A}$). Thus, the capitalized value at the end of the year equals the sum of last year's value to the extent that remains unamortized and this year's investments. Inputs into this model come from Section 3.

We estimate the modified book value by adding the sum of knowledge capital and organization capital to the standard book value:

$$BV^{mod}_{i,t} = BV_{i,t} + Intan\_Cap_{i,t}^{mod}, \tag{5}$$

where $BV^{mod}_{i,t}$ denotes modified book value of equity per share for firm *i* in year *t*. $Intan\_Cap^{mod}$ represents capitalized internally generated intangible assets divided by outstanding shares.

Table 3, Panel A, presents the descriptive statistics of the effects of capitalization for the full sample. The mean (median) as-reported book value per share is $9.12 ($6.12), which represents about half of the mean (median) stock price per share of $19.92 ($12.25). These numbers imply a mean (median) market-to-book ratio of 2.18 (2.00). After capitalization of internally generated capital stock, the average book value becomes $13.64 per share, which is an increase of $4.52 or an average of 49.56%. This increase is attributable to an average of $0.88 per share because of R&D capitalization (knowledge capital) and an average of $4.05 per share because of MainSG&A capitalization (organization capital). The impact of capitalization of MainSG&A is therefore much larger than that of R&D.

[Insert Table 3 near here]

Panel B presents the modified book value as well as the modified market-to-book ratio by industry. The information is ordered by the as-reported market-to-book ratio. The top five industries are pharmaceutical products, medical equipment, business services, tobacco products, and computers. For most intangible-intensive industries, the bigger changes are observed in (i) pharmaceutical products (book value increases by 91% and market-to-book ratio decreases by 43%); (ii) medical equipment (book value increases by 61% and market-to-book ratio decreases by 36%); (iii) business services (book value increases by 54% and market-to-book ratio decreases by 30%); (iv) tobacco products (book value increases by 62% and market-to-book ratio decreases by 20%); and (v) computers (book value increases by 33% and market-to-book ratio decreases by 20%). In contrast, for many old-economy industries, such as transportation, business supplies, and shipbuilding, no significant change is evident in book value or the market-to-book ratio.

5. Testing the Validity of Modified Book Value

We conduct three tests to assess our claim that an external analyst could benefit from using these industry-specific investment portions and amortization schedules of R&D and SG&A instead of (a) ignoring them in capitalized assets or (b) using ad hoc, uniform portion and amortization schedules, or both. First, we examine whether the book-to-market ratio, calculated with our revised book value, is more strongly associated with future returns compared with ones based on as-reported book value. Second, we follow Peters and Taylor (2017) to assess whether Tobin's Q calculated using our modified book value is more strongly associated with total future investments. Third, we examine whether the Altman Z-score calculated with our modified total assets and retained earnings is a better predictor of bankruptcy for manufacturing firms than metrics based on as-reported values. For two of the three tests, we also examine whether results are stronger for industries that are generally considered to be more intangible intensive.

5.1 Association with future stock returns

We examine whether book-to-market ratio (*BTM*) is associated with future risk-adjusted returns (Fama and French 1993; Lakonishok, Schleifer, and Vishny 1994). We estimate the regression

$$Returns_{i,t+1} = \alpha + \beta_1 \times BTM_{i,t} + \beta_2 \times (Rm - Rf)_{t+1} + \beta_3 \times SMB_{t+1} + \beta_4 \times HML_{t+1} + \beta_5 \times RMW_{t+1} + \beta_6 \times CMA_{t+1} + \varepsilon_{i,t+1}, \quad (6)$$

where *Returns* is the annual stock returns of the firm i in year $t + 1$. The risk factors come from Fama and French (2015): $R_m - R_f$, *SMB* (small minus big), *HML* (high minus low), *RMW* (robust minus weak), and *CMA* (conservative minus aggressive), all measured contemporaneously with returns in year $t + 1$.[12] The coefficient on *BTM* indicates whether the book-to-market ratio is associated with future returns after controlling for contemporaneous risk factors. We compare β_1 based on our modified book-to-market with β_1 based on as-reported book value. We also compare

[12] They are calculating by compounding the last 12-month factors ending in the fiscal year month. Monthly factors are obtained from Ken French's website.

with book value calculated using the Peters and Taylor method, which relies on mechanical capitalization.[13]

Panel A of Table 4 presents the results for the full sample. It shows that the coefficient on our modified book-to-market ratio is 0.106, which is 28% and 8% higher, respectively, than the coefficients of 0.083 based on Peters and Taylor's book-to-market ratio and 0.098 based on as-reported book value. It is noteworthy that capitalization based on uniform rates has lower association with future returns compared with as-reported book values, on average. All risk factors are significant except for HML because HML is a factor derived from the as-reported book-to-market ratio.

[Insert Table 4 near here]

Panels B to E of Table 4 present results by major industry sectors: manufacturing, consumer, high-tech, and health, respectively. For high-tech industries, our measure outperforms (coefficient of 0.146) as-reported book-to-market ratio (0.087) and the Peters and Taylor book-to-market (0.097) by 67.82% and 50.52%, respectively. Similarly, for health-tech industries, our measure outperforms (coefficient of 0.217) as-reported book-to-market ratio (0.193) and the Peters and Taylor book-to-market ratio (0.153) by 41.83% and 12.44%, respectively. Our measure also outperforms for the consumer industry by 12.22% and 21.69%, respectively. Nevertheless, both the Peters and Taylor ratio and our measure under-perform as-reported book value for the manufacturing industry.

[13] Book value based on Peters and Taylor (2017) is the sum of reported physical capital, reported acquired intangibles, and carrying amount of capitalized in-house intangibles. They estimate capitalized in-house intangibles by capitalizing 100% of R&D expenses and 30% of MainSG&A. For amortizing R&D, they rely on BEA industry-specific R&D depreciation rates, to the extent available. Otherwise, they use a flat 15% as the depreciation rate. For MainSG&A capital, they use a flat 20% depreciation rate.

To the extent that value relevance is a qualitative indicator of financial statement analysis, the results show that our method of capitalization provides a better measure for capitalized assets of intangible-intensive industries than the reported book values or the values based on ad hoc, uniform capitalization.

5.2 Explanatory power for investment-Q relation

Peters and Taylor (2017) establish the superiority of their measure, compare with as-reported book value, by testing whether their modified Tobin's Q predicts future operating investments. They find that Tobin's Q measured using their method outperforms the one calculated with as-reported book value.

Fazzari, Hubbard, and Petersen (1988) and Erickson and Whited (2012) measure Tobin's Q as

$$q = \frac{V}{K^{phy}}, \qquad (7)$$

where q denotes Tobin's Q. The replacement cost of physical capital, K^{phy}, is measured by the book value of property, plant, and equipment, and the firm's market value, V, is measured by the market value of outstanding equity, plus the book value of debt, minus the firm's current assets. Peters and Taylor introduce a new measure of Tobin's Q (denoted as q^{PT}), which scales the firm value by the sum of physical and intangible capital:

$$q^{PT} = \frac{V}{K^{phy} + Intan + Intan\_Cap^{PT}}. \qquad (8)$$

The main innovation introduced by Peters and Taylor is the inclusion of intangible capital in the denominator. They measure intangible capital as the sum of intangible assets recognized on the balance sheet (*Intan*) and internally generated intangible assets ($Intan\_Cap^{PT}$).

To assess whether $Intan\_Cap^{mod}$ provides a more precise measure of the unrecognized intangible capital of a firm, we recalculate Tobin's Q by replacing $Intan\_Cap^{PT}$ with our measure of $Intan\_Cap^{mod}$, as previously defined, and label that as q^{mod} (modified Tobin's Q):

$$q^{mod} = \frac{V}{K^{phy} + Intan \;\; + Intan\_Cap^{mod}}. \tag{9}$$

Following Peters and Taylor (2017), we compare the R-squared of the regression.[14]

$$Investment_{i,t} = Tobin's\ Q_{i,t\text{-}1} + fixed\_effects + \varepsilon_{i,t}, \tag{10}$$

where *Investment* represents total investments inclusive of capitalized intangible investments and *fixed_effects* are the firm and year fixed effects. A higher R-squared inclusive of intangible investments implies that the modified Tobin's Q measure is a better proxy for firms' investment opportunities. We test the significance of the difference in R^2 using the methodology discussed in Vuong (1989).

Table 5 presents the results of this analysis. Panel A shows that the mean (median) of Tobin's Q based on as-reported number is 4.07 (1.23). The mean Tobin's Q using the Peters and Taylor (2017) method declines dramatically to 1.10, because of a significant increase in book value. The median goes below one to 0.64. The mean Tobin's Q calculated using our method is 1.37, indicating that increase in book value, and therefore the decrease in Tobin's Q, is not as much as the one calculated using mechanical capitalization.

[Insert Table 5 near here]

Panel B of Table 5 compares the R-squared of the regressions for the three Tobin's Q measures in the full sample. R-squared measured with q^{PT} (30.29%) is higher than that with q

[14] We report within-R^2 following Peters and Taylor (2017).

(22.28%). Our measure increase it further to 31.75%, an improvement of 42.50% and 4.82% over those based on q and q^{PT}. We repeat this test for major industrial sectors (manufacturing, consumer, high-tech, and health) and present results in Panels C to F of Table 5. For high-tech industries, our proposed method improves R-squared by 19.87% over the one based on reported value, but not over q^{PT}. For health industries, the improvements in the reported value over q and q^{PT} are 52.91% and 5.49%, respectively. For manufacturing and retail industries, our measure outperforms q and q^{PT} by 37.30% and 0.39%.

Tobin's Q proposed by Peters and Taylor (2017) has become one of the most commonly used variables in empirical accounting, finance, and economics studies. In that context, a measure incorporating industry-specific capitalization and amortization rates would improve the measurement of Tobin's Q compared with the one based on mechanical capitalization.[15]

5.3 Bankruptcy prediction

The Altman Z-score (Altman 1968) was developed to predict the bankruptcies of manufacturing companies. The score uses reported profits, assets, and retained earnings, which are affected by expensing of intangibles (see the Appendix for calculations). We examine whether the Altman Z-score calculated with our modified profits, total assets, and retained earnings is a better predictor of bankruptcy than the model estimated with reported values.

We calculate three versions of the Z-score based on as-reported numbers, Peters and Taylor's adjustments, and our modifications, for manufacturing companies. We obtain the list of firms that filed for bankruptcy during 1990–2018 from the UCLA-LoPucki Bankruptcy Research

[15] The Peters and Taylor (2017) estimation of 30% capitalization rate is based on multiple attempts and selecting the one that gives the best result (within-R^2 in Eq. 10). So, beating that best result, even by a minor amount, amounts to beating all other combinations.

Database.[16] To compare the predictive ability of three measures of the Altman Z-score, we estimate the following logistic regression for the manufacturing sector and compare their pseudo R^2:

$$Bankruptcy_{i,t+2} = \alpha + \beta \times AltmanZPredictor_{i,t} + \varepsilon, \quad (16)$$

where $Bankruptcy_{i,t+2}$ is a binary variable that takes the value of one if the firm files for bankruptcy in two years from the current year and zero otherwise. An Altman Z-score below 1.81 indicates severe financial constraints and potential for bankruptcy, and a score above 2.99 is considered the safe zone. Thus, we create an indicator variable, *AltmanZPredictor*, that takes the value of one if the Altman Z-score is below 1.81 and zero otherwise. Table 6 presents the results of this analysis. The Altman Z-score calculated using our modified measure improves pseudo R^2 by 18.18% and 11.14% as compared with the standard measure and the one calculated using Peters and Taylor's methodology, respectively.[17]

[Insert Table 6 near here]

6. Conclusion

Because of the omission of an important class of assets (i.e., in-house intangibles) from balance sheets, there is a growing demand for improved estimates of book values from the users of financial statements. Numerous recent studies provide estimates of book values by using mechanical rules of thumb, such as the capitalization on 30% of SG&A and 100% of R&D, and assuming five and seven years in the lives of those investments. We propose a new inductive method to estimate the capitalization and amortization rates for in-house intangible investments. We estimate the investment portion of R&D (or MainSG&A) as well as its useful life

[16] See https://lopucki.law.ucla.edu/.

[17] Consistent with results from logistic regressions, Pearson correlations (untabulated) between $Bankruptcy_{i,t+2}$ and *AltmanZPredictor* are 0.062, 0.059, and 0.056 based on our modified Z-score, Peters and Taylor's method, and as-reported Z-score, respectively.

simultaneously from a regression with *R&D* (or *MainSG&A*) as the dependent variable and current and future revenues as independent variables. We identify useful life as the optimal number of future revenues that maximizes the adjusted *R*-squared of the regression. We estimate the investment portion as the part of intangible expenditures associated with future revenues. We allow these parameter estimates to vary by industry, thereby accommodating the heterogeneity in characteristics, and productive lives of these intangible investments, across industries. We argue that our approach should lead to better identification of intangible expenditures that produce future benefits and exclusion of those that turn out to be unproductive, ex post. Ideally, from a financial statement user perspective, the former should be capitalized and included in the assets, but the latter should not be.

Using the parameter estimates from our refined method, we compute the capitalized value of internally generated intangible investments and add the capitalized value to reported book value to derive our modified book value. We show that our modified book value exhibits greater association with future risk-adjusted returns, future investments, and bankruptcy probability per the Altman Z-score model, relative to both as-reported book value and the mechanically adjusted book value as per Peters and Taylor (2017). Our study contributes to the literature by providing a better estimate of book value that can be used by consumers of financial statements, particularly those that rely on some mechanical rule of thumb to estimate revised book values.

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Appendix: Variable Definitions

Variable	**Definition**
AltmanZPredictor	Indicator variable that equals one if the Altman Z-score is below 1.81 and zero otherwise. Altman Z-score is calculated as *AltmanZ* = 1.2X1 + 1.4X2 + 3.3X3 + 0.6X4 + 0.999X5, where X1 = working capital / total assets, X2 = retained earnings / total assets, X3 = earnings before interest and taxes / total assets, X4 = market value of equity / total liabilities, and X5 = sales / total assets. We modify total assets, retained earnings, and earnings before interest and taxes as follows: $Assets\_mod = Assets + Intan\_Cap^{mod}$, $NetIncome\_mod = NetIncome + (Intan\_Cap^{mod} - lagIntan\_Cap^{mod})$, and $RetainedEarnings\_mod = RetainedEarnings + Intan\_Cap^{mod}$.
As-reported BV	Book value of equity per share (Compustat variable *bkvlps*).
Assets	Compustat variable *at*
Book to Market Ratio	*As-reported BV / prcc_f*
BV^{PT}	Book value per share as calculated according to Peters and Taylor (2017) as $BV^{PT} = BV + Intan\_Cap^{PT}$, where *BV* denotes reported book value of equity per share and $Intan\_Cap^{PT}$ represents capitalized internally generated intangible assets according to Peters and Taylor (2017) divided by outstanding shares.
CMA	Conservative minus aggressive, the "investment factor," is one of the five risk factors from Fama and French (2015)
HML	High minus low, the "value premium" is one of the five risk factors from Fama and French (2015)
$Intan\_Cap^{mod}$	Modified stock of internally generated intangible assets by capitalizing investment portions of R&D and MainSG&A expenses with a straight-line amortization based on the industry-level optimal lag structure. It is calculated as $K + O$. See Sections 3 and 4 for a detailed description of calculation procedure.
$Intan\_Cap^{PT}$	Stock of internally generated intangible assets calculated by Peters and Taylor (2017) by capitalizing 100% of R&D expenses and 30% of MainSG&A. Obtained from WRDS.
Investment_MainSG&A	Investment portions of MainSG&A. See Sections 3 and 4 for a detailed description of calculation procedure.
Investment_R&D	Investment portions of R&D. See Sections 3 and 4 for a detailed description of calculation procedure.

Knowledge Capital (K)	Knowledge capital that represents the intangible assets developed internally by spending on research and development. It is calculated as $(1 - \delta_{R\&D}) \times K_{-1}$ + *Investment_R&D*. See Sections 3 and 4 for a detailed description of calculation procedure.
K^{phy}	Replacement cost of physical capital measured by the book value of property, plant, and equipment (Compustat variable item *ppegt*).
MainSG&A	*SG&A − R&D – RDIP*.
MainSG&A_Amort	(Presumed) amortization expenses of capitalized R&D and MainSG&A.
Market to Book Ratio	Market to Book ratio is calculated as (*prcc_f* × *csho* + *lt* + *pstk*)/*at* Where compustat variables *prcc_f*, *csho*,*lt*,*pstk* and *at* represent price per share, number of shares outstanding, long-term assets, preferred shares and total assets respectively.
Modified Book Value (BV^{mod})	Modified book value is calculated as $BV^{mod} = BV + Intan\_Cap^{mod}$, where BV^{mod} denotes modified book value for firm *i* in year *t*, *BV* denotes reported book value of equity per share, and $Intan\_Cap^{mod}$ represents capitalized internally generated intangible assets divided by outstanding shares.
Organization Capital $(O)_{i,t}$	Organizational capital that represents the knowledge used to combine human skills and tangible capital into systems for producing and delivering products. It is calculated as $(1 - \delta_{SG\&A}) \times O_{i,t-1}$ + $Investment\_MainSG\&A_{i,t}$.
P	Share price of firm *i* at the end of the year *t*.
q	Tobin's Q calculated as $q = \frac{V_{i,t}}{K_{i,t}^{phy}}$, where *q* denotes Tobin's Q. The replacement cost of physical capital, K^{phy}, is measured by the book value of property, plant, and equipment, and the firm's market value, *V*, is measured by the market value of outstanding equity, plus the book value of debt, minus the firm's current assets.
q^{mod}	Modified Tobin's Q calculated as $q_{i,t}^{mod} = \frac{V_{i,t}}{K_{i,t}^{phy} + Intan_{i,t} + Intan\_Cap_{i,t}^{mod}}$.
q^{PT}	Tobin's Q by Peters and Taylor (2017) calculated as $q_{i,t}^{PT} = \frac{V_{i,t}}{K_{i,t}^{phy} + Intan_{i,t} + Intan\_Cap_{i,t}^{PT}}$.
R&D	R&D outlays (Compustat variable *xrd*).
RD_Amort	(Presumed) amortization expenses of capitalized R&D.
RDIP	In-process research and development expense (Compustat variable *rdip*).

Return	Annual stock return calculated as [(End-of-Year Share Price {*prcc_f*}/Adjustment Factor {*ajex*}+Dividend per Share {*dvsp_f*}/AdjustmentFactor − Beginning-of-Year Share Price/Beginning-of-Year Adjustment Factor) / (Beginning-of-Year Share Price/ Beginning-of-Year Adjustment Factor)].
Revenues	Revenue (Compustat variable *sale*).
Rm-Rf	Market risk premium, one of the five risk factors from Fama and French (2015)
RMW	Robust minus weak, the “profitability factor” is one of the five risk factors from Fama and French (2015)
Sales	Compustat variable *sale*
SG&A	Compustat variable *xsga*: “[A]ll commercial expenses of operation (i.e., expenses not directly related to product production) incurred in the regular course of business pertaining to the securing of operating income.” It includes immediately expensed costs in activities such as R&D, marketing, advertising, training, and sales promotion and excludes cost classified as cost of sales (Compustat variable *cogs*). This item excludes depreciation allocated to the SG&A category. This item is scaled by average total assets.
SMB	Small minus big, the "small firm effect," or the "size effect” is one of the five risk factors from Fama and French (2015)
Stock Price	Compustat variable *prcc_f*
V	Firm’s market value is measured by the market value of outstanding equity (Compustat variables items *prcc_f* times *csho*), plus the book value of debt (Compustat variables items *dltt* + *dlc*), minus the firm’s current assets (Compustat variable item *act*).
$\delta_{Ind,R\&D}$	Amortization rate of investment portions of R&D. It is 1/useful life for R&D for that industry, which is calculated based on procedure described in Section 3.
$\delta_{Ind,SG\&A}$	Amortization rate of investment portions of MainSG&A. It is 1/useful life for MainSG&A for that industry, which is calculated based on procedure described in Section 3.

TABLE 1

Sample Selection

This table describes our sample selection steps over our sample period of 1980–2018. WRDS = Wharton Research Data Services; SIC = Standard Industrial Classification.

Selection Step	Number of Observations
All Compustat firm-year observations between 1950 and 2018	408,907
Excluding observations with missing values for intangible capital stock provided by Peters and Taylor (2017) in WRDS	(136,156)
	272,751
Excluding with missing SIC codes, all finance firms (Fama-French industries 44, 45, 46, and 47), regulated utilities (Fama-French industry 31), and firms in the "almost nothing" category (Fama-French industry 48)	(61,852)
	210,899
Excluding observations with missing total assets, sales, number of shares outstanding, book value per share, capital expenditure, earnings per share, net income or share price less than $1	(37,562)
	173,337
Excluding observations with missing lags	(15,359)
	157,978
Selecting sample years from 1975 to 2018	(17,795)
Number of Firm-Year Observations	**140,183**
Number of Unique Firms	**13,649**

TABLE 2

Improving the Measured Value of Internally Generated Intangibles

This table presents results of the two steps that we implement to improve the measured value of internally generated intangibles. Panel A presents sample characteristics, and Panel B reports the estimation results by Fama-French 48 industries (excluding finance firms and firms in the "almost nothing" category) sorted by market-to-book ratio based on reported values. In step 1, we identify the portion of MainSG&A expenditure [selling, general, and administrative (SG&A) expenses other than research and development (R&D)] or R&D that covary with current revenue as the maintenance portion and the remaining value as the investment portion or the portion of R&D or MainSG&A that we capitalize. In step 2, we estimate the productive lives of R&D and MainSG&A capitals. We estimate the optimal number of lagged investment values that maximize the adjusted *R*-squared from a regression of future operating earnings on lagged investment values. *Assets* and *Sales* are total assets and total revenue. See the Appendix for variable definitions.

Panel A: Sample Characteristics

Variable	*N*	Mean	Standard Deviation	25th Percentile	Median	75th Percentile
Assets	140,183	3,467.70	18,260.00	44.72	203.58	1,107.69
Sales	140,183	2,804.28	13,790.00	41.44	200.46	1,031.60
R&D	140,183	71.32	495.59	0.00	0.00	9.21
MainSG&A	140,183	379.68	1,820.81	6.64	30.35	143.89

Panel B: Investment Portion and Optimal Number of Lags

Industry	Number of Observations		Investment Portion		Optimal Number of Lags	
	MainSG&A	***R&D***	***MainSG&A***	***R&D***	***MainSG&A***	***R&D***
Pharmaceutical Products	2,591	2,232	0.71	0.92	2	7
Medical Equipment	2,495	2,112	0.73	0.89	1	7
Business Services	7,235	2,919	0.59	0.61	2	7
Tobacco Products	136	25	0.54	0.76	3	5
Computers	3,349	2,735	0.57	0.74	0	6
Measuring and Control Equipment	2,252	1,872	0.60	0.80	2	0
Personal Services	878	60	0.54	0.76	3	5
Electronic Equipment	6,141	4,922	0.61	0.77	3	7
Healthcare	936	125	0.60	0.76	0	5
Entertainment	1,260	74	0.46	0.76	2	5
Beer & Liquor	486	86	0.54	0.76	3	5
Printing and Publishing	919	51	0.54	0.76	3	5
Defense	176	115	0.54	0.76	3	5
Electrical Equipment	1,972	1,219	0.58	0.63	4	7
Consumer Goods	2,564	1,196	0.40	0.85	3	6
Communication	2,194	363	0.59	0.71	4	6
Chemicals	2,777	1,841	0.41	0.63	4	2
Non-Metallic and Industrial Metal Mining	1,097	115	0.78	0.76	4	5
Meals	1,826	73	0.55	0.76	1	5
Agriculture	308	70	0.54	0.76	3	5
Recreation	989	487	0.40	0.81	1	0
Food Products	2,736	705	0.56	0.78	4	4
Retail	6,001	96	0.35	0.76	4	5
Machinery	4,811	3,213	0.55	0.82	3	3
Apparel	1,888	196	0.34	0.76	0	5
Petroleum and Natural Gas	5,735	915	0.73	0.71	3	0
Rubber and Plastic Products	1,310	518	0.47	0.87	2	0
Aircraft	820	448	0.54	0.85	3	6
Shipbuilding	217	102	0.54	0.76	3	5
Automobiles and Trucks	2,351	1,355	0.60	0.83	3	7
Wholesale	4,783	426	0.72	0.91	4	0
Business Supplies	2,363	824	0.01	0.64	4	6
Construction Materials	3,902	1,369	0.57	0.70	3	5
Shipping Containers	474	165	0.54	0.76	3	5
Transportation	1,697	38	0.06	0.76	3	5
Construction	1,446	86	0.55	0.76	2	5
Coal	215	38	0.54	0.76	3	5
Fabricated Products	567	164	0.54	0.76	3	5
Steel Works Etc.	2,307	747	0.70	0.74	3	7
Textiles	930	208	0.30	0.76	1	5
Weighted Average			0.54	0.77	2.73	5.08

TABLE 3

Impact of Measured Value of In-house Intangibles on Book Values and Earnings

This table shows the impact of measured value of internally generated intangibles on book values, earnings, and market-to-book ratio. Panel A presents the results for the full sample. Panel B reports the results by Fama-French 48 industries (excluding finance firms and firms in the "almost nothing" category) sorted by market-to-book ratio based on reported values. *As-reported Book Value* represents Compustat variable *bkvlps*. We calculate *Knowledge Capital* and *Organizational Capital* by applying the perpetual inventory method to the investment portions of research and development and MainSG&A, respectively. *Modified Book Value* is calculated as-reported book value plus knowledge capital and organizational capital. *Stock Price* represents Compustat variable *prcc_f*. See the Appendix for variable definitions. *N* = 140,183.

Panel A: Full Sample

Variable	*N*	Mean	Standard Deviation	25th Percentile	Median	75th Percentile
As-reported Book Value	140,183	9.12	10.32	2.42	6.12	12.17
Knowledge Capital	140,183	113.86	664.81	0.00	0.00	14.77
Organization Capital	140,183	303.03	1183.83	2.87	20.37	113.07
Modified Book Value	140,183	13.64	14.55	4.15	9.11	17.83
Stock Price	140,183	19.92	23.64	4.75	12.25	26.54

TABLE 3 Continued

Panel B: By Fama-French 48 Industries

Industry	**Book Value**			**Market-to-Book Ratio**		
	Reported	**Modified**	**Difference (%)**	**As Reported**	**Modified**	**Difference (%)**
Pharmaceutical Products	4.69	***8.96***	91.00	**3.65**	**2.07**	−43.21
Medical Equipment	5.72	***9.18***	60.62	**3.02**	**1.94**	−35.70
Business Services	5.88	***9.06***	53.99	**2.65**	**1.87**	−29.27
Tobacco Products	12.72	**20.57**	61.71	**2.48**	**1.99**	−19.88
Computers	6.11	***8.15***	33.45	**2.36**	**1.87**	−20.47
Measuring and Control Eqp	7.08	***10.01***	41.46	**2.06**	**1.61**	−21.64
Personal Services	8.21	12.96	57.95	**2.06**	1.55	−24.73
Electronic Equipment	7.03	11.39	61.98	**2.04**	1.41	−30.89
Healthcare	6.75	***6.89***	2.13	**1.96**	**1.86**	−5.38
Entertainment	6.95	***8.59***	23.64	**1.90**	**1.63**	−13.96
Beer & Liquor	14.07	**20.61**	46.52	1.88	1.52	−19.34
Printing and Publishing	11.07	**18.27**	65.05	1.88	1.41	−25.24
Defense	10.87	16.97	56.10	1.85	1.47	−20.66
Electrical Equipment	9.59	16.63	73.46	1.83	***1.26***	−31.36
Consumer Goods	10.30	17.13	66.25	1.83	***1.33***	−27.51
Communication	9.25	12.72	37.50	1.82	1.52	−16.44
Chemicals	13.15	**19.07**	45.05	1.79	1.47	−18.12
Mining	11.63	14.37	23.57	1.79	1.56	−12.79
Meals	6.82	***8.21***	20.45	1.79	**1.61**	−10.15
Agriculture	9.42	12.02	27.56	1.78	1.54	−13.42
Recreation	7.72	***9.71***	25.75	1.76	1.49	−15.39
Food Products	12.19	**21.02**	72.33	1.74	***1.26***	−27.57
Retail	10.33	**20.16**	95.16	1.72	***1.24***	−27.97
Machinery	10.95	17.32	58.24	1.69	***1.28***	−24.27
Apparel	10.37	***10.57***	2.01	***1.67***	**1.64**	−2.27
Petroleum and Natural Gas	11.69	13.94	19.30	***1.65***	1.46	−11.29
Rubber and Plastic Products	8.93	12.29	37.57	***1.59***	1.35	−14.72
Aircraft	17.13	**25.76**	50.35	***1.58***	***1.31***	−16.95
Shipbuilding	11.07	13.96	26.10	***1.57***	1.35	−13.93
Automobiles and Trucks	13.54	**21.40**	58.03	***1.56***	***1.22***	−22.01
Wholesale	9.98	**21.19**	112.44	***1.55***	***1.04***	−32.77
Business Supplies	13.51	14.30	5.87	***1.49***	1.43	−3.63
Construction Materials	12.54	**18.14**	44.65	***1.46***	***1.18***	−19.22
Shipping Containers	12.59	17.50	39.01	***1.45***	***1.25***	−13.80
Transportation	14.20	14.88	4.86	1.44	1.40	−2.55
Construction	10.99	14.37	30.82	1.34	1.20	−10.62
Coal	13.97	17.58	25.80	1.33	1.26	−5.33
Fabricated Products	10.17	14.90	46.48	1.30	1.09	−16.02
Steel Works Etc	14.90	19.58	31.42	1.27	1.11	−12.87
Textiles	12.40	14.56	17.41	1.24	1.13	−8.84

TABLE 4

In-house Intangible Capital and Risk-adjusted Returns

This table presents results of the association between book-to-market ratio (*BTM*) and future risk-adjusted stock returns, estimated by

$$Returns_{i,t+1} = \alpha + \beta_1 \times BTM_{i,t} + \beta_2 \times (Rm - Rf)_{t+1} + \beta_3 \times SMB_{t+1} + \beta_4 \times HML_{t+1} + \beta_5 \times RMW_{t+1} + \beta_6 \times CMA_{t+1} + \varepsilon_{i,t+1},$$

Where dependent variable is annual stock return (*Returns*) calculated in the year after the measurement of *BTM*. R_m-R_f, *SMB* (small minus big), *HML* (high minus low), *RMW* (robust minus weak), and *CMA* (conservative minus aggressive) are the five risk factors from Fama and French (2015), measured contemporaneously with the return calculation. They are calculated by compounding monthly data obtained from Ken French's website. The *t*-statistics are in parentheses, and *, **, and *** represent the significance of differences at the 10%, 5%, and 1% level, respectively, in two-tailed *t*-tests. See the Appendix for variable definitions. PT = Peters and Taylor (2017).

Panel A: Full Sample

Variable	As Reported	PT	Modified
Book-to-Market Ratio	0.098***	0.083***	0.106***
	(17.42)	(33.34)	(32.38)
R_m-R_f (t+1)	0.842***	0.812***	0.814***
	(32.74)	(31.67)	(31.75)
SMB(t+1)	0.828***	0.796***	0.789***
	(23.65)	(22.83)	(22.62)
HML(t+1)	0.006	0.014	0.019
	(0.17)	(0.38)	(0.50)
RMW(t+1)	−0.173***	−0.188***	−0.190***
	(−3.99)	(−4.35)	(−4.41)
CMA(t+1)	0.189***	0.154***	0.147***
	(3.49)	(2.84)	(2.71)
Constant	−0.001	−0.041***	−0.044***
	(−0.13)	(−7.16)	(−7.44)
N	111,415	111,415	111,415
Adjusted R^2	2.91	3.61	3.55
Percentage difference in coefficient on *Book-to-Market Ratio*			
Modified over As Reported			8.16%***
Modified over PT			27.71%***

TABLE 4 Continued

Panel B: Manufacturing

Variable	As Reported	PT	Modified
Book-to-Market Ratio	0.132***	0.072***	0.088***
	(18.76)	(26.43)	(25.07)
R_m-R_f (t+1)	0.692***	0.673***	0.681***
	(20.19)	(19.74)	(19.94)
SMB(t+1)	0.607***	0.600***	0.596***
	(13.01)	(12.97)	(12.85)
HML(t+1)	0.116**	0.111**	0.111**
	(2.26)	(2.18)	(2.17)
RMW(t+1)	0.159***	0.151***	0.153***
	(2.79)	(2.66)	(2.70)
CMA(t+1)	−0.025	−0.046	−0.040
	(−0.34)	(−0.63)	(−0.54)
Constant	−0.041***	−0.059***	−0.059***
	(−5.04)	(−7.58)	(−7.50)
N	27,671	11,509	27,671
Adjusted R^2	4.38	3.57	5.32
Percentage difference in coefficient on *Book-to-Market Ratio*			
Modified over As Reported			-33.33%***
Modified over PT			22.22%***

Panel C: Consumer

Variable	As Reported	PT	Modified
Book-to-Market Ratio	0.090***	0.083***	0.101***
	(10.95)	(21.08)	(19.30)
R_m-R_f (t+1)	0.968***	0.939***	0.942***
	(24.99)	(24.36)	(24.41)
SMB(t+1)	0.897***	0.862***	0.859***
	(17.04)	(16.50)	(16.40)
HML(t+1)	0.219***	0.221***	0.224***
	(3.73)	(3.80)	(3.84)
RMW(t+1)	0.096	0.080	0.080
	(1.46)	(1.22)	(1.22)
CMA(t+1)	0.030	−0.014	−0.014
	(0.36)	(−0.17)	(−0.17)
Constant	−0.043***	−0.082***	−0.082***
	(−4.64)	(−9.22)	(−8.95)
N	27,711	27,711	27,711
Adjusted R^2	5.43	6.52	6.28
Percentage difference in coefficient on *Book-to-Market Ratio*			
Modified over As Reported			12.22%***
Modified over PT			21.69%***

TABLE 4 Continued

Panel D: High-tech

Variable	As Reported	PT	Modified
Book-to-Market Ratio	0.087***	0.097***	0.146***
	(4.52)	(11.52)	(12.89)
R_m-R_f $(t+1)$	0.883***	0.793***	0.829***
	(11.63)	(10.93)	(10.94)
SMB$(t+1)$	0.894***	0.862***	0.827***
	(8.58)	(8.76)	(7.96)
HML$(t+1)$	−0.321***	−0.281***	−0.274**
	(−2.86)	(−2.58)	(−2.45)
RMW$(t+1)$	−0.820***	0.046	−0.841***
	(−6.43)	(0.37)	(−6.61)
CMA$(t+1)$	0.585***	0.603***	0.525***
	(3.73)	(4.02)	(3.36)
Constant	0.063***	0.001	−0.018
	(3.59)	(0.07)	(−1.02)
N	28,886	28,886	28,886
Adjusted R^2	2.25	2.63	2.74
Percentage difference in coefficient on *Book-to-Market Ratio*			
Modified over As Reported			67.82%***
Modified over PT			50.52%***

Panel E: Health

Variable	As Reported	PT	Modified
Book-to-Market Ratio	0.193***	0.153***	0.217***
	(8.83)	(16.55)	(16.70)
R_m-R_f $(t+1)$	0.835***	0.793***	0.792***
	(11.42)	(10.93)	(10.92)
SMB$(t+1)$	0.936***	0.862***	0.862***
	(9.45)	(8.76)	(8.77)
HML$(t+1)$	−0.360***	−0.281***	−0.274**
	(−3.27)	(−2.58)	(−2.51)
RMW$(t+1)$	0.046	0.046	0.033
	(0.37)	(0.37)	(0.27)
CMA$(t+1)$	0.674***	0.603***	0.577***
	(4.46)	(4.02)	(3.85)
Constant	−0.007	−0.059***	−0.084***
	(−0.45)	(−7.50)	(−5.11)
N	11,509	11,509	11,509
Adjusted R^2	3.57	5.18	5.22
Percentage difference in coefficient on *Book-to-Market Ratio*			
Modified over As Reported			12.44%***
Modified over PT			41.83%***

TABLE 5

Improvement in the Association between Investments and Tobin's Q

This table compares the within-firm R^2 of the ordinary least squares panel regressions of the physical, intangible, and total investments on three measures of lagged Tobin's Q. Standard Tobin's Q is Tobin's Q based on reported numbers, measured as the firm's market value divided by the replacement cost of physical capital, measured by the book value of property, plant, and equipment. PT's Tobin's *q* is Tobin's Q from Peters and Taylor (2017). Modified Tobin's Q is Tobin's Q based on our method. Total Investment equals physical investment plus intangible investment, where physical investment equals capital expenditure (capx) and intangible investment equals investment portions of research and development (R&D) and selling, general, and administrative (MainSG&A) expenses. The *t*-statistics are in parentheses, and *, **, and *** represent the significance of differences at the 10%, 5%, and 1% level, respectively, in two-tailed *t*-tests. See the Appendix for variable definitions.

Panel A: Descriptive statistics for Tobin's Q

Variable	*N*	Mean	Standard Deviation	25th Percentile	Median	75th Percentile
q	118,517	4.07	9.95	0.49	1.23	3.53
q^{PT}	118,517	1.10	1.91	0.26	0.64	1.26
q^{Mod}	118,517	1.37	2.44	0.32	0.74	1.49

Panel B: Full Sample

	Dependent variable is Total Investment		
Variable	**Standard**	**PT**	**Modified**
Tobin's *q*	0.005***	0.028***	0.035***
	(30.65)	(36.47)	(41.11)
Constant	0.296***	0.281***	0.416***
	(93.89)	(91.38)	(96.80)
N	117,343	117,343	117,343
Within-firm R^2	22.28	30.29	31.75
Improvement in within-firm R^2			
Modified over Standard			42.50%
Modified over PT			4.82%

TABLE 5 Continued

Panel C: Manufacturing

	Dependent variable is Total Investment		
Variable	**Standard**	**PT**	**Modified**
*lag*_Tobin's *q*	0.007***	0.039***	0.048***
	(6.79)	(21.98)	(20.84)
Constant	0.257***	0.244***	0.376***
	(62.09)	(62.55)	(64.01)
N	29,448	29,448	29,448
Within-firm R^2	22.68	31.02	31.14
Improvement in within-firm R^2			
Modified over Standard			37.30%***
Modified over PT			0.39%***

Panel D: Consumer

	Dependent variable is Total Investment		
Variable	**Standard**	**PT**	**Modified**
*lag*_Tobin's *q*	0.008***	0.043***	0.047***
	(6.42)	(13.05)	(15.32)
Constant	0.251***	0.232***	0.314***
	(52.58)	(48.54)	(52.89)
N	30,784	30,784	30,784
Within-firm R^2	15.85	22.91	23.43
Improvement in within-firm R^2			
Modified over Standard			47.82%***
Modified over PT			2.27%***

TABLE 5 Continued

Panel E: High-tech

	Dependent variable is Total Investment		
Variable	**Standard**	**PT**	**Modified**
*lag*_Tobin's *q*	0.004***	0.024***	0.030***
	(23.73)	(28.33)	(31.60)
Constant	0.418***	0.400***	0.623***
	(38.25)	(38.74)	(40.23)
N	29,253	29,253	29,253
Within-firm R^2	35.98	43.61	43.13
Improvement in within-firm R^2			
Modified over Standard			19.87%***
Modified over PT			-1.10%***

Panel F: Health

	Dependent variable is Total Investment		
Variable	**Standard**	**PT**	**Modified**
*lag*_Tobin's *q*	0.003***	0.029***	0.039***
	(11.47)	(13.75)	(16.30)
Constant	0.341***	0.314***	0.539***
	(21.90)	(21.96)	(23.50)
N	11,083	11,083	11,083
Within-firm R^2	20.98	30.41	32.08
Improvement in within-firm R^2			
Modified over Standard			52.91%***
Modified over PT			5.49%***

TABLE 6

Improvement in Bankruptcy Prediction of Altman's Z-score for Manufacturing Firms

This table compares the pseudo R^2 of the logistic regressions, which estimate the likelihood of bankruptcy of manufacturing firms, using three sets of financial measure. *Bankruptcy* is an indicator variable that equals one if the firm files for bankruptcy in the next two years and zero otherwise. *AltmanZPredictor* is an indicator variable that equals one if Altman Z-score is below 1.81 and zero otherwise. The Peters and Taylor (2017) Altman's Z-score and modified Altman's Z-score are calculated by adjusting the reported total assets, retained earnings, and net income by the capitalized portion of internally generated intangible capital based on our modification as explained in Section 3. The chi-square statistics are in parentheses, and *, **, and *** represent the significance of differences at the 10%, 5%, and 1% level, respectively, in two-tailed chi-square tests. See the Appendix for variable definitions.

Variable	**Dependent variable is *Bankruptcy***		
AltmanZPredictor (Standard)	1.462		
	(88.23)		
AltmanZPredictor (PT)		1.529	
		(95.54)	
AltmanZPredictor (Modified)			1.592
			(105.28)
Constant	-5.647	-5.642	-5.678
	(3,208)	(3,267)	(3,180)
N	33,448	33,448	33,448
Pseudo R^2	3.63	3.86	4.29
Difference in pseudo R^2			
Modified − PT			11.14%
Modified − Standard			18.18%