# Intangible Asset Specificity

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## Abstract

Kermani and Ma (2023) provide a database of asset-level liquidation recovery rates for non-financial industries. A notable feature of their data is the high average recovery rates for intangible assets, which are comparable to those of fixed assets. Using these rates, Kermani and Ma conclude that rising investment in intangibles has not significantly reduced firm-level liquidation values. We revisit their data and computations, showing that their high intangible recovery rates stem from including recoveries for off-balance-sheet assets in the recovery rate numerator (asset liquidation value), while excluding investments in off-balance-sheet assets from the recovery rate denominator (asset book value). After incorporating estimates of investments in off-balance-sheet intangibles, we find that: (i) intangible recovery rates drop by an order of magnitude, (ii) rising investment in intangibles has reduced firm-level liquidation values, and (iii) economic theories linking corporate policy decisions to asset specificity receive strong empirical support.

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# 1 Introduction

Asset specificity represents the extent to which an asset's value is tied to a specific use or user. Assets with low specificity, cash being an extreme example, are easily adapted to alternative uses with little loss in value. Assets with high specificity, such as specialized machinery, are not easily adapted to alternative uses, and thus suffer large drops in value if transferred outside their current application. Consequently, investments in highly specific assets tend to be irreversible. This irreversibility has implications for organizational structure (Williamson, 1996), investment decisions (Abel and Eberly, 1996; Kim and Kung, 2017), and financing decisions (Titman and Wessels, 1988). The growing prevalence of intangible assets has heightened the importance of asset specificity because intangibles are generally considered to have very high specificity (e.g., Giglio and Severo, 2012; Falato, Kadyrzhanova, Sim and Steri, 2022; Garfinkel, Khetan, and Nain, 2025).[1]

While asset specificity has been the subject of much research, measuring it has proven challenging.[2] Recent research by Kermani and Ma (2023) addresses this challenge by providing a set of liquidation recovery rates for major asset categories across all major non-financial industries. These recovery rates are collected from a large sample of liquidation analyses provided in Chapter 11 bankruptcy filings. Kermani and Ma graciously make their data publicly available, and it has been used in subsequent research to estimate liquidation values (e.g., Ma and Scheinkman 2020; Lian and Ma 2021; Bae and Kim 2025; Pandey 2024; Li et al. 2025) and to estimate theoretical model parameters related to firm recoveries (Buera et al. 2024; Faria-e-castro et al. 2024).[3]

The liquidation recovery rates provided by Kermani and Ma (K&M, hereafter) largely align with economic intuition. For example, receivables recovery rates are generally high, ranging from 20% in transportation services to 100% in furniture stores. PP&E recovery rates are generally lower, ranging from 4% in automotive dealers to 62% in transportation services. Recovery rates

[1] For evidence on the growing prevalence of intangibles see, for example, Haskel and Westlake (2018).
[2] For examples of such research, see the references in Delbufalo (2021) and Kermani and Ma (2023).
[3] Aleszczyk, Vasvari, and Vyas (2024) also collect recovery rates from Chapter 11 filings and report recovery rates by asset class that are similar to those in Kermani and Ma. Aleszczyk et al. focus on the implications of uncertainty in recovery rates for debt contracting.

for intangibles, however, are more puzzling. For example, the recovery rates for nongoodwill intangibles range from a low of 0% in several industries to a high of 166% in textile products. Moreover, the average recovery rate for nongoodwill intangibles across all industries is 32%, which is only slightly below the 35% average for PP&E. Based on these rates, K&M conclude that nongoodwill intangibles are not necessarily more specific than tangible assets—such as PP&E—and that the growing prevalence of intangible assets has not significantly reduced firms' liquidation values. These results contradict prior research maintaining that intangible assets have extremely high specificity (e.g., Giglio and Severo, 2012; Falato, Kadyrzhanova, Sim and Steri, 2022).

Given the important and puzzling nature of K&M's findings for intangible assets, we revisit their data and computations. Computing recovery rates for intangible assets is complicated by inconsistencies in their accounting treatment. While tangible assets are typically recorded on the balance sheet at amortized cost, intangible assets are subject to three different accounting treatments:

(i) Purchased intangibles that are identifiable and have finite lives are accounted for on the balance sheet at amortized cost (like most tangible assets).

(ii) Purchased intangibles that have indefinite lives are accounted for on the balance sheet at cost subject to periodic impairment.

(iii) Internally generated intangibles are generally expensed as incurred and do not appear on the balance sheet.

The accounting for internally generated intangibles poses a particular challenge for estimating liquidation recovery rates. K&M compute recovery rates by dividing the estimated liquidation values of intangibles by the book values of intangibles provided within the bankruptcy liquidation analyses. However, this approach potentially inflates recovery rates because the estimated liquidation values can include recoveries from both purchased and internally generated intangibles, while the book values reflect only purchased intangibles. Omitting investments in internally generated intangible assets from the denominator biases recovery rates in two ways:

(i) Firms with purchased intangibles on the books have overstated recovery rates. These overstatements can be extreme, because the thus-computed recovery rates have a lower

bound of zero, but an unlimited upper bound (i.e., in cases where book intangibles are very small relative to off-balance-sheet intangibles, even small recovery rates on off-balance-sheet intangibles can produce extremely high thus-estimated recovery rates).[4]

(ii) Firms with no purchased intangibles on the books have 'undefined' recovery rates (because the denominator is zero) and are omitted from the analysis. As a result, recovery rates are only available for firms with purchased intangibles (where they are overstated).

To address the potential upward bias in K&M's intangible asset recovery rates, we recompute these rates while incorporating the Peters and Taylor (2017) estimates of investments in internally generated intangibles in the denominator. We also compute recovery rates for firms that, while having no book intangibles, do have investments in off-balance-sheet intangibles. These adjustments lead to a sharp reduction in recovery rates. For example, the industry average recovery rate for intangibles drops from the 25% reported in K&M to less than 3%. Furthermore, using our revised recovery rates, we find that the growing prevalence of intangible assets has reduced firms' liquidation values. Finally, we show that economic theories relating asset specificity to capital structure, investment policy, and organizational structure are strongly supported after incorporating investments in off-balance-sheet intangibles.

We finish by acknowledging potential sources of error in our revised recovery rates. These include (i) measurement error in estimates of off-balance-sheet intangibles, (ii) measurement error in book intangibles resulting from asset impairments, (iii) measurement error in book intangibles resulting from changes in accounting rules, and (iv) measurement error in blended intangible recovery rates resulting from differences in recovery rates across different types of intangibles. We don't believe that these sources of error impact our primary conclusions regarding the extremely low recovery values for intangibles and the associated reduction in firms' liquidation recovery values. At the same time, we find that the use of a single sample-wide average recovery

[4] Hills, Kubik and Schipper (2024) provide evidence consistent with the omission of internally generated intangibles leading to such biases. They examine asset revaluations following the initiation of fresh start reporting in a sample of 243 Chapter 11 reorganizations. This process involves revaluing all assets, including internally generated intangibles, to fair value. While there are only 9 cases of upward revaluations exceeding 100% for PP&E, there are 101 such cases for intangibles. The difference can be explained by the inclusion of internally generated intangibles.

rate produces estimates that are about as accurate as using our revised industry-level average recovery rates.

Our findings have important implications for research on intangible asset specificity. First, our findings suggest that investments in intangible assets have extremely high specificity. This finding is consistent with assumptions in earlier research, but inconsistent with the findings in K&M. We, therefore, caution against using the intangible recovery rates provided in K&M to either draw conclusions about intangible asset specificity or to estimate intangible asset recoveries. Second, and in contrast to K&M, we find that the growing prevalence of intangibles over time has been associated with reductions in firms' liquidation values. This finding corroborates previous research concluding that the rise of intangible assets has impacted firms' financing decisions (e.g., Caggese and Pérez-Orive, 2022; Falato, Kadyrzhanova, Sim and Steri, 2022). Third, we describe additional issues with the estimation of intangible asset recovery rates that also apply to our revised industry-level rates. Thus, we recommend caution in relying on industry-level estimates of intangible asset recovery rates and highlight the need for further research in this area.

The remainder of the paper is organized as follows. Section 2 describes the liquidation analyses accompanying Chapter 11 bankruptcies and the associated implications for estimating intangible asset liquidation recovery rates. Section 3 describes our data and research design, Section 4 presents empirical results, Section 5 describes other issues impacting the estimation of intangible asset recovery rates, and Section 6 concludes.

# 2 Liquidation Analyses, Accounting for Intangibles, and the Estimation of Intangible Asset Liquidation Recovery Rates

## 2.1 Liquidation Analyses

Section 1129(a)(7) of the Bankruptcy Code requires that each holder of an impaired claim in a Chapter 11 (reorganization plan) bankruptcy either (i) accepts the plan; or (ii) receives property or value of the plan that is not less than the value they would receive if the debtor was liquidated under Chapter 7 of the Bankruptcy Code. This requirement is commonly known as the "best interests of creditors" test, as it ensures that all creditors in a reorganization receive at least as

much as they would under a liquidation. To meet this test, debtors are required to prepare hypothetical liquidation analyses as of the effective date of the Chapter 11 reorganization plan. The liquidation plan is prepared by the debtor and is typically done in consultation with a valuation expert.

The Bankruptcy Code does not specify the formal procedures to be used in conducting the liquidation analysis. Commonly accepted practice is to obtain a balance sheet as of or shortly before the effective date of the reorganization plan and to apply estimated liquidation recovery rates to each asset category on the balance sheet. For example, cash would typically receive a recovery rate of around 100%, while goodwill would typically receive a recovery rate of around 0%, with most other asset categories receiving rates that lie between these two extremes.

A complication arising in applying recovery rates to balance sheet categories is that certain assets are not recorded on the books. For example, and as described in more detail below, many intangible assets are not recorded on the balance sheet. In such cases, liquidation analyses should still include amounts that are expected to be recovered from the liquidation of these "off-balance-sheet" intangibles. For example, one valuation expert notes that the estimated liquidation value must consider the existence of unrecorded items, including patents, trademarks, and customer lists.[5] The existence of off-balance-sheet intangibles complicates the calculation and interpretation of liquidation recovery rates. Specifically, two types of cases can arise. In the first case, both off-balance-sheet and on-balance-sheet intangibles exist. In this case, reported recovery rates overstate actual recovery rates, because total recoveries are included in the numerator, but only investments in on-balance-sheet intangibles are included in the denominator. These overstatements can be very large when on-balance-sheet intangibles are very small relative to off-balance-sheet assets (e.g., a firm with large pre-existing internally generated intangibles purchases a small amount of intangibles). In the second case, only off-balance-sheet intangibles exist (i.e., no book intangibles). In this case, recovery rates are undefined, because the denominator is zero. Thus, while the liquidation analysis may include the dollar amount of expected recoveries from the liquidation of off-balance-sheet assets, a recovery rate is not defined and will not typically be provided in the

[5] See https://www.meadenmoore.com/blog/consulting/valuation-matters-when-a-company-is-liquidating

liquidation analysis.

A potential solution to this complication is to add estimates of amortized costs for off-balance-sheet intangibles to the reported book values. Doing so requires identification and measurement of the off-balance-sheet intangibles. To guide the identification and measurement of these off-balance-sheet intangibles, we summarize the accounting for intangibles below.

### 2.2 Accounting for Intangible Assets

The accounting for intangibles is complex and nuanced. We first summarize the general rules and then highlight nuances that are particularly relevant to the estimation of liquidation recovery rates. The general rule is that internally generated intangibles are expensed as incurred—and hence off-balance-sheet—while acquired intangibles are capitalized on the balance sheet. Acquired intangibles are initially capitalized at cost, with subsequent measurement depending on whether the intangible asset is judged to have a definite life (e.g., a patent) or an indefinite life (e.g., a trademark that is expected to be indefinitely renewed). Definite-lived intangibles are amortized over their estimated useful lives and subject to periodic recoverability-based impairment tests, while indefinite-lived assets are not amortized but are subject to periodic fair-value-based impairment tests.

These general rules have two important implications for the estimation of liquidation recovery rates using accounting book values in the denominator. First, as mentioned above, because internally generated intangibles do not appear on the balance sheet, they will be excluded from the denominator of recovery rates. Firms with only internally generated intangibles will therefore have undefined recovery rates, while firms with a combination of internally generated and acquired intangibles will have overstated recovery rates. Second, because intangibles are subject to periodic impairment, their book values may understate their amortized cost. These impairments are more likely for firms approaching bankruptcy, which will bias recovery rates for bankrupt firms upwards towards 100%.

Additional accounting nuances also impact the estimation of liquidation recovery rates. First, while most internally generated intangibles are expensed as incurred, certain costs are capitalized. For example, the research and development costs associated with developing a patent are not

capitalized, but the legal costs associated with filing a patent are capitalized. Software development costs are another example, where certain advanced-stage software development costs are required to be capitalized. The upshot of these rules is that internally generated intangibles may have some book value, but this book value will typically significantly understate investments in these intangible assets. This, in turn, will lead to overstated recovery rates.

The natural solution to these overstatements is to estimate the amount invested in off-balance-sheet intangibles and add it to the reported book values used in the denominators of the recovery rates. Unfortunately, obtaining these amounts is not straightforward. First, we need to identify amounts invested in internally generated intangible assets from prior periods that were expensed as incurred. Second, we need to estimate the aggregate amortized amounts of these investments as of the hypothetical liquidation date. The financial statements typically provide little information about which expenses represent investments in intangibles or their associated estimated useful lives. Previous research has proposed various procedures for estimating these amounts. We use the approach developed by Peters and Taylor (2017), as it is widely used in previous research (e.g., Ghaly et al 2017; Klasa et al. 2018; Hasan et al. 2021; Falato et al. 2022; K&M 2023) and produces relatively conservative estimates.[6]

Peters and Taylor (P&T hereafter) estimate a firm's off-balance-sheet intangible capital at a given point in time by applying the perpetual inventory method to expenditures that are expensed immediately for accounting purposes but likely generate intangible assets. The required inputs for this calculation are the periodic expenditures and the applicable amortization rate:

$I_{i,k,t} = (1-\delta_k)I_{i,k,t-1} + E_{i,k,t}$

where:

$I_{i,k,t}$ = the ending stock of investment in intangible capital of type k for firm i at time t

$\delta_k$ = the amortization rate for intangible capital of type k

$E_{i,k,t}$ = expenditures that are likely to generate intangible capital of type k by firm i during period t and are expensed as incurred for accounting purposes.

[6] An alternative approach popularized by Eisfeldt and Papanikolaou (2013) produces larger estimates of off-balance-sheet intangibles by capitalizing 100% of non-R&D-related SG&A expenses, whereas Peters and Taylor (2017) capitalize only 30% of such expenses.

P&T identify two types of intangible capital: knowledge capital and organization capital. With respect to knowledge capital, P&T use 100% of research and development expense (R&D) along with the industry-specific R&D depreciation rates provided by the Bureau of Economic Analysis.[7] With respect to organization capital, P&T use 30% of selling, general, and administrative expense (SG&A) along with an amortization rate of 20%. The stocks of intangible capital are summed across these two types of intangibles to estimate total off-balance-sheet intangible assets.

P&T acknowledge that their assumptions, particularly the assumptions for organization capital, are rough estimates that are unlikely to be appropriate for many firms. A related shortcoming is that many expenditures relating to internally generated intangible capital are classified in cost of goods sold instead of R&D or SG&A. Such expenditures include employee training for manufacturers, emissions credits for chemical producers, and slots, gates & routes for airlines. Thus, our results should be interpreted with these limitations in mind.

### 2.3 Examples

To illustrate the importance of incorporating off-balance-sheet intangibles in the estimation of liquidation recovery rates, we present three examples for airlines from K&M's sample of bankruptcy filings. The exhibit below summarizes each example by listing the book value of intangibles, the expected recovery value in liquidation, the K&M liquidation recovery rate, the P&T estimate of off-balance-sheet intangibles, and our revised recovery rate.

| Company | BV of Intangibles | Expected Recoveries | K&M Recovery Rate | P&T Off-BS Intangibles | Our Revised Recovery Rate |
|---|---|---|---|---|---|
| AMR Corp | 868,962 | 3,944,679 | 421% | 3,560,926 | 89% |
| Frontier Airlines | - | 19,700 | - | 195,423 | 10% |
| Mesa Airlines | - | - | - | 118,900 | 0% |

#### 2.3.1 AMR Corporation

The liquidation analysis for AMR Corporation is provided as Panel A in Appendix 1. Intangible assets consist of (i) "Routes, Airport Slots & Gate Costs" with a book value of 868,962 and an

[7] The BEA analysis only provides amortization rates for 10 R&D intensive industries. P&T state that they follow the BEA guidelines of 15% for other industries.

estimated orderly recovery of 3,655,679; and (ii) "Intangible Assets" with a missing book value and an estimated orderly recovery of 289,000. This leads K&M to record a liquidation recovery rate of 3,655,679/868,962=421%. Note that K&M exclude the 289,000 recovery on "Intangible Assets" because they have no book value. While the resulting recovery rate is extremely favorable, note that it includes only the book value of acquired Routes, Slots, and Gates in the denominator. Moreover, these book values are dated December 31, 2012, and AMR's last major acquisition was for a much smaller airline (TWA) back in 2001. This caused AMR's book intangibles to peak at 2,717,000 at the end of 2001 and subsequently shrink to 868,962 by the end of 2012 through a combination of amortization and impairments. Importantly, the amortized and impaired book value of the old TWA intangibles from 2001 excludes all internal investments made by AMR to support its "Routes, Airport Slots & Gate Costs" through 2012.

To address these issues, we adjust the numerator of the recovery rate to include all intangible recoveries, and we adjust the denominator to include the P&T estimate of net investments in off-balance-sheet intangibles. Total recoveries are 3,655,679+289,000=3,944,679. The P&T estimate of off-balance-sheet intangible capital is 3,560,926 at the end of 2010 (the last fiscal year it was provided by P&T prior to AMR's bankruptcy filing). Recall that this amount is based on past R&D and SG&A expenditures. AMR recorded no R&D expenses, and its SG&A expenses amount to less than 20% of total operating costs. Compustat classifies the remaining operating costs in Cost of Goods Sold. In AMR's case, it would also seem appropriate to capitalize some of the past expenditures from Cost of Goods Sold into off-balance-sheet intangibles. Establishing profitable routes can require expenditures to train ground staff and to operate new routes at a loss in their early days. Moreover, not all new routes become profitable and some are subsequently cancelled. Expenditures on these unsuccessful routes can also be considered a necessary investment to develop profitable routes. While we don't attempt such an exercise here, we highlight that P&T's approach likely understates investments in off-balance-sheet intangibles for AMR.[8] Nevertheless, including the P&T intangibles in the denominator of the recovery rate reduces it substantially from

[8] Prior to 2003, Compustat classified all of AMR's SG&A expense in Cost of Goods Sold, which causes additional understatement in the P&T estimate.

421% to 3,944,679/(868,962+3,560,926)=89%.

### 2.3.2 Frontier Airlines

The liquidation analysis for Frontier Airlines is provided as Panel B in Appendix 1. Intangible assets are listed in the recovery analysis with no book value and a recovery value of 19,700. The associated note indicates that these intangibles have no book value because they are "not included in the Debtors' April 30, 2009 general ledger". In this case, K&M do not record a recovery rate, because the denominator is missing and the recovery rate is, therefore, undefined. The denominator is missing because Frontier does not have any acquired intangibles. Yet, as with AMR, Frontier has likely made significant ongoing investments in internally generated intangibles. The P&T estimate of investments in off-balance-sheet intangibles at the end of March 2008 (the last fiscal year it was provided by P&T prior to Frontier's bankruptcy filing) is 195,423. Including this estimate of internally generated intangibles in the denominator of the liquidation recovery rate produces a recovery rate of 10%. This recovery rate is excluded from K&M's original database due to the missing book value for intangibles. K&M report an average industry nongoodwill intangible recovery rate for 'Transportation By Air' of 152%. Thus, excluding this observation leads to an overstatement in the average industry recovery rate.

### 2.3.3 Mesa Airlines

The liquidation analysis for Mesa Airlines is provided as Panel C in Appendix 1. Intangible assets are not listed in the recovery analysis. Since the liquidation analysis should include estimates of all amounts recoverable in liquidation, we interpret the omission to indicate that both the book value and the estimated recoverable amount for intangibles are zero (or negligible) for Mesa. Yet, as with AMR and Frontier, Mesa has likely made significant ongoing investments in internally generated intangibles. The P&T estimate for investment in off-balance-sheet intangible assets at the end of September 2008 (the last fiscal year an estimate was provided by P&T prior to Mesa's filing for bankruptcy) is 118,900. Including this estimate of internally generated intangibles in the denominator of the liquidation recovery rate generates a recovery rate of 0%. This recovery rate is also excluded from K&M's original database, which reports an average industry nongoodwill

intangible recovery rate for 'Transportation By Air' of 152%. Thus, excluding this observation leads to an overstatement in the average industry recovery rate.

Together, these three examples illustrate the two previously discussed types of biases that result from omitting off-balance-sheet intangibles from liquidation recovery rates. First, as illustrated by the AMR example, when a firm has a combination of both purchased and internally generated intangibles, the omission of internally generated intangibles from the denominator will lead to a systematic overstatement of the liquidation recovery rate. Second, as illustrated by the Frontier and Mesa examples, when a firm has only internally generated intangibles, the omission of internally generated intangibles from the denominator renders the recovery rate undefined and so it is omitted from K&M's original analysis. Thus, liquidation recovery rates are only computed for firms with acquired intangibles, where they are upwardly biased. Our subsequent empirical analysis attempts to quantify these biases by incorporating P&T's off-balance-sheet estimates.

### 2.4 Biases in Estimates of Implied Intangible Liquidation Values for Compustat Firms

Our previous analysis indicates that omitting off-balance-sheet intangibles from the calculation of liquidation recovery rates causes the rates to be upwardly biased. An important finding in K&M is that when applying their recovery rates to all Compustat firms at different points in time, the average implied firm-level liquidation values appear stable over time. In other words, K&M find that the growing prevalence of intangibles has *not* led to a significant reduction in firm-level liquidation values, due in part to the high recovery rates for intangibles. This raises the natural question: Are these results biased due to the use of upwardly biased liquidation recovery rates for intangibles? The answer is not obvious. While excluding off-balance-sheet intangibles from the denominator overstates recovery rates, these rates are only applied to the book value of the acquired intangibles for Compustat firms—which also omit off-balance-sheet intangibles. Thus, we need to consider whether omitting the off-balance-sheet intangibles from both (i) the denominator of the estimated liquidation recovery rates, and (ii) the intangibles amounts to which these rates are applied, leads to biased estimates of intangible recovery values for the Compustat firms. To do so, we define two variables and one parameter:

$O$ = off-balance-sheet intangibles variable with mean $o$

$B$ = on-balance-sheet intangibles variable with mean $b$

$r$ = recovery rate parameter (assumed constant)

The ideal approach for estimating the average intangible recovery values of Compustat firms is to first compute the recovery rate for firms in the bankruptcy sample:

$r$ = intangible recovery/(off-balance-sheet intangibles + on-balance-sheet intangibles)

$= r^*(O+B)/(O+B) = r$

Next, $r$ is applied to the sum of the on- and off-balance-sheet intangibles for firms on Compustat to estimate implied intangible recovery values:

Estimated intangible recovery value = $r^*(O+B)$

Taking expectations yields:

Expected intangible recovery value = $r^*(o+b)$ (1)

Because $O$ is not observable, K&M assume $O = 0$ when calculating recovery rates using the bankruptcy sample and estimate the recovery rate as:

$r'$ = intangible recovery/(on-balance-sheet intangibles) = $r^*(O+B)/(B)$

The K&M expected recovery rate is then:

$E[r'] = r^*(E[O/B]+1)$

Applying this recovery rate to the book value of intangibles for firms on Compustat yields:

K&M estimated intangible recovery = $r^*(E[O/B]^*B + B)$

And taking expectations yields:

K&M Expected intangible recovery = $r^*(E[O/B]^*b + b)$ (2)

Comparing equations (1) and (2), we can see that the relation between the estimated intangible recovery values depends on the relation between $o$ and $E[O/B]^*b$. If we assume that $O$ and $B$ are positive independent random variables, then:

$E[O/B]^*b = o^*E[1/B]^*b \geq o$ by Jensen's (1906) inequality,

implying that the approach used by K&M will overstate intangible liquidation recovery values for Compustat firms. Intuitively, the upward bias arises because introducing error into the denominator causes the expected value of the ratio ($E[O/B]$) to exceed the ratio of the expected values of the numerator and denominator ($o/b$).

The intuition behind this upward bias can be illustrated through a simple example. Assume that we have three bankrupt firms, each with off-balance-sheet intangibles of 100 and a combined bankruptcy recovery rate for on- and off-balance-sheet intangibles of 10%. Further, assume that on-balance-sheet intangibles for each firm are 20, 100, and 180, respectively. Applying the 10% recovery rate to the combined intangibles yields actual recovery values of 12, 20, and 28, respectively. The average estimated K&M recovery rate using only on-balance-sheet book values in the denominator is (12/20+20/100+28/180)/3=(60%+20%+15.6%)/3=31.9%. Thus, the K&M estimated recovery rate of 31.9% overstates the true recovery rate of 10%. Furthermore, applying the K&M recovery rate to each firm's book intangibles yields estimated recovery values of 6.4, 31.9, and 57.4, respectively. Thus, the estimated recovery values are too low for the low-book-value firm and too high for the mid- and high-book-value firms, and the average estimated recovery value of 31.9 exceeds the average actual recovery of 20.

Note that the above analysis assumes that that $O$ and $B$ are positive independent random variables. Relaxing these assumptions changes the analysis. First, if $O$ and $B$ are positively correlated, the upward bias in recovery rates is attenuated and is eliminated in the case of a perfect positive correlation. Modifying our previous example, if all firms have a book value of intangibles that is equal to off-balance-sheet intangibles of 100, the average recovery rate would still be overstated (i.e., it would be 20%), but the estimated recovery values would equal the actual recovery values of 20. Second, when $B$ equals zero (i.e., no acquired intangibles), a positive recovery for off-balance-sheet intangibles generates an undefined (infinite) recovery rate. As mentioned previously, K&M exclude such cases from the average estimated recovery rates in their bankruptcy sample. However, they also assume a zero-recovery value for all Compustat firms with missing book values for intangibles. This will lead to an understatement in estimated recovery values because firms with no book intangibles on Compustat are assumed to have no recoveries, even though such firms sometimes realize positive recovery values in the bankruptcy sample.

In summary, this analysis shows how the K&M approach overstates recovery values for mid- and high-book-value firms and understates recovery values for low- and zero-book-value firms. The impact on sample averages will depend on the characteristics of the underlying data and is addressed

through our empirical analysis.

## 3 Data and Research Design

K&M's sample is based on a list of U.S. public companies that emerged from Chapter 11 bankruptcy between 2000 and 2018 and is derived from New Generation Research's bankruptcy database.[9] Their data consists of 519 observations, of which 477 have liquidation analyses and 441 have a non-missing recovery rate for at least one of the following asset categories: (i) cash, (ii) receivables, (iii) inventory, (iv) PP&E, (v) book intangibles (the sum of nongoodwill book intangibles and book goodwill), and (vi) nongoodwill book intangibles. For each available asset category, recovery rates are computed by dividing the midpoint estimate of the recovery in an orderly liquidation of the asset by the book value of the asset. Thus, an important underlying assumption in K&M's analysis is that all intangible recoveries relate to book intangibles. In practice, however, some recovery amounts will relate to off-balance-sheet intangibles, leading to the previously mentioned overstatements in K&M's recovery rates.

One issue encountered when collecting recovery rates for nongoodwill book intangibles is that nongoodwill intangibles (also referred to as identifiable or separable intangibles) are often combined with goodwill for the purpose of reporting recoveries. In such cases, K&M estimate the recovery rate for nongoodwill book intangibles by assuming that (i) the proportion of nongoodwill intangibles is constant within industries, and (ii) book goodwill has a recovery rate of zero. They then use the recovery on book intangibles along with the industry average proportion of nongoodwill intangibles to infer the nongoodwill book intangible recovery rate.

K&M report summary statistics on their recovery rates after averaging at the industry level using two-digit SIC codes. To provide additional granularity, we start by reporting *firm*-level summary statistics. Table 1 reports firm-level summary statistics for K&M's recovery rates, and Figure 1 plots the distributions of these recovery rates. Cash recovery rates are unsurprisingly clustered around 100%. Receivables recovery rates are clustered around 70% with a long, left tail pulling the average

[9] K&M make their data and code available at: https://doi.org/10.7910/DVN/FZGQBX.

recovery down to 64%. Inventory recovery rates are more dispersed, ranging between 0% and 100% with an average of 46%. PP&E recovery rates are also dispersed, with most falling between 0 and 50%, a mean of 35%, and a right tail extending to 123%.[10] Intangible recovery rates, however, have a strikingly different distribution. Recovery rates are clustered between 0% and 10%, but with a very long right tail extending to 799%. This long right tail boosts the average nongoodwill book intangible recovery rate to 33% and average book intangible recovery rate (which includes goodwill) to 27%. Thus, while the average recovery rates for PP&E and intangibles appear similar, their distributions differ sharply: most firms have intangible recovery rates that are far lower than those for PP&E, but a few extreme positive outliers drive up the average intangible recovery rates.

K&M document significant variation in their average recovery rates across two-digit industry classifications. A priori, the extent to which this variation represents underlying variation in the population averages versus sampling error is unclear. We therefore conduct analyses to assess the reliability of K&M's industry-level estimates. We start by analyzing the proportion of industries with more than one, three, and five firm-bankruptcy observations underlying each industry average. Results are presented in Table 2 Panel A. For cash, receivables, inventory, and PP&E, 81-92% of industries have more than one observation, though this falls to 44-50% when requiring at least five firms. In contrast, book intangibles and nongoodwill book intangibles show weaker coverage: only 74% of industries have more than one firm, and just 33% have more than five. Given that intangible recovery rates are right-skewed and prone to extreme outliers, these thin sample sizes raise concern that variation in the associated industry averages is dominated by sampling error.

To investigate further, we examine K&M's firm-level recovery rates as a function of the respective average industry recovery rate obtained using all other firms in the industry. Specifically, we estimate a 'hold one out' regression following K&M:[11]

$$\lambda_{ijk} = \alpha + \beta \bar{\lambda}_{(-i)jk} + \varepsilon_{ijk} \quad (3)$$

[10] The 123% recovery rate relates to the oil and gas properties of a firm called PetroQuest Energy, Inc. that were subject to large impairments following sharp reductions in oil and gas prices. The price reductions forced PetroQuest into bankruptcy, but had rebounded somewhat by the time of bankruptcy, resulting in recovery rates exceeding 100% of the previously impaired values. Section 5.2 provides a more detailed discussion of the impact of asset impairments on reported recovery rates.

[11] K&M only report results for PP&E. We obtain similarly significant results for PP&E but find no significant results for intangibles.

where $\lambda_{ijk}$ is the firm-level liquidation recovery rate for firm $i$ in industry $j$ and asset type $k$, and $\bar{\lambda}_{(-i)jk}$ is the industry-level recovery rate for industry $j$ and asset type $k$ using all other firms in industry $j$ except for firm $i$. Table 2 Panel B presents results for PP&E and nongoodwill book intangibles using industry-level recovery rates based on industries with more than one, three, and five firm-bankruptcy observations respectively. In the first three columns, industry-level PP&E recovery rates significantly predict firm-level recoveries, with beta coefficients rising from 0.354 to 0.697 as the number of contributing firms increases, indicating greater reliability with larger sample sizes. Untabulated regressions examining recovery rates for cash, receivables, and inventory show qualitatively similar results to those for PP&E. In contrast, the final three columns show that industry-level recovery rates for nongoodwill intangibles are not significantly associated with firm-level rates for any sample size. These findings suggest that cross-sectional variation in industry-level intangible recovery rates reflects sampling error rather than variation in the underlying population means.[12]

Having established that K&M's industry-level average intangible recovery rates are dominated by sampling error, we next analyze our primary hypothesized source of error. K&M assume that all intangible recoveries relate to nongoodwill book intangibles. Yet, in practice, the recoveries also include amounts related to off-balance-sheet intangibles. We address this issue by assuming that the recovery rates for on- and off-balance-sheet intangibles are the same and estimating an adjusted recovery rate that includes both book intangibles and the P&T estimate of off-balance-sheet intangibles in the denominator.[13]

We begin by locating the liquidation analyses from which K&M's recovery rates are derived. We start with the 441 bankruptcies for which K&M report a recovery rate for at least one asset class and further exclude two cases where the only asset class with a recovery rate is cash. This leaves 439 bankruptcies. Using the Public Access to Electronic Records (PACER) system, we locate the

[12] Untabulated regressions analyzing book intangibles show qualitatively similar results to those presented for nongoodwill book intangibles.

[13] We investigate the sensitivity of the results to the assumption that recovery rates are the same for book and off-balance-sheet intangibles in Section 5.4.

liquidation analyses used to derive the K&M recovery rates for these bankruptcies.[14] For a further five cases, we are also able to locate recovery rates that appear to have been overlooked by K&M, for a total of 444 bankruptcy cases. Finally, to incorporate off-balance-sheet intangibles in our recovery rates, we require a P&T estimate of off-balance-sheet intangibles prior to bankruptcy. Since the sample consists of bankruptcies for public companies, we are able to find 391 of the cases on Compustat using either the CIK code provided by K&M in their dataset or a manual examination of cases with no initial CIK match. In all cases, we take the most recently available P&T value from a fiscal year that pre-dates the bankruptcy filing and is not from more than four years prior to the bankruptcy filing. After linking to Compustat, we are unable to find a value for off-balance-sheet intangibles in the P&T dataset on WRDS for 64 cases. This leaves us with a final sample of 327 bankruptcies. Panel A of Table 3 summarizes our sample construction.

We next analyze the liquidation analyses in these 327 bankruptcies to compute our own intangible asset liquidation recovery rates. Panel B of Table 3 reconciles our adjusted intangible recovery rates to K&M's original intangible recovery rates. For 133 cases, we find the same book values and intangible asset recovery rates as in K&M's database, and so we simply add the P&T off-balance-sheet estimates to the denominator. For the other 193 cases, we make additional adjustments to the recovery rates. First, for 22 cases, we find that the liquidation analysis does not list a book value for intangibles but does list a dollar recovery. For these cases, we assume that the recoveries relate to off-balance-sheet intangibles. K&M set these recovery rates to missing because the denominator of the recovery rate is missing, and so their recovery rate is undefined. We instead assume that these recoveries relate exclusively to off-balance-sheet intangibles and divide the recovery amount by the P&T estimate of off-balance-sheet intangibles to derive the recovery rate. For a further 161 cases, we find no book values or recoveries for intangible assets in the liquidation analysis along with a non-zero P&T estimate of off-balance-sheet intangibles. For these cases, we set the recovery rate to zero, because there was no recovery despite a positive off-balance-sheet investment in intangibles. Finally, we find different recovery rates from K&M in 11 cases.

[14] We were initially unable to locate the liquidation analyses for a number of bankruptcies, and we are grateful to Amir Kermani and Yueran Ma for kindly providing us with these liquidation analyses.

It is important to understand the assumptions underlying our adjusted intangible asset recovery rates. Our combined nongoodwill and goodwill "Intangibles" recovery rates implicitly assume that the expected recovery rates on off-balance-sheet intangibles equal the expected recovery rates on book intangibles. Our "Nongoodwill Intangibles" recovery rates make the stronger assumption that the expected recovery rates on off-balance-sheet intangibles equal the expected recovery rates on nongoodwill book intangibles. This assumption is more questionable, because the off-balance-sheet intangibles should include some goodwill-like intangibles that have no recoveries. For this reason, the remainder of our analysis focuses on recovery rates for the combined "Intangibles" category. We also examine the robustness of our results to alternative assumptions concerning the relative recovery rates for off-balance-sheet and book intangibles in Section 5.4.

# 4 Results

## 4.1 Adjusted Recovery Rates

We begin by analyzing how the K&M recovery rates change when we incorporate our adjustments. Since our primary adjustment is to incorporate the P&T estimates of off-balance-sheet intangibles in recovery rate denominators, we begin by providing descriptive evidence on magnitudes and time trends for this adjustment. Figure 2 plots the time series of on- and off-balance-sheet intangibles, scaled by total assets. Panel A provides asset-weighted averages (i.e., we sum the numerators and denominators across firms for available firm-years on Compustat and then take the ratio), while Panel B provides equal-weighted averages (i.e., we take the average of firm-level ratios). The asset-weighted averages show that both book (i.e., on-balance-sheet) and off-balance-sheet intangible assets average about 15% of total assets, though book intangibles steadily increase over the sample period. In contrast, the equal-weighted averages show that book intangibles are only about 10% of total assets, while off-balance-sheet intangibles are much larger, averaging about 30% of total assets. Book intangibles again show steady growth over the sample period. The greater relative magnitude of off-balance-sheet intangibles in the equal-weighted results suggests that large firms are more likely to grow through acquisitions, while small firms are more likely to grow organically.

The steady growth in book intangibles is potentially problematic for K&M's estimates of time-trends in intangible recoveries. If recovery rates on total intangibles have been constant, but the relative proportion of book versus off-balance-sheet intangibles has increased over the sample period, then recoveries should mechanically fall as a percentage of book intangibles. Applying the sample-wide average recovery rates to book intangibles at different points in time will then lead to a mechanical increase in estimated recoveries over the sample period. We return to this issue and discuss an accounting-related explanation for the increase in book intangibles in Section 5.3.

Having established that off-balance-sheet intangibles are material, we next analyze how their inclusion impacts recovery rates. Table 4 presents summary statistics on industry-level recovery rates. To fully reconcile our adjusted recovery rates with K&M's original rates, Panel A of Table 4 presents the adjusted rates in five steps. In the first step, we start with the 211 observations in K&M that have a non-missing intangible recovery rate, which have an industry-level mean recovery rate of 24.83% for book intangibles. Next, we incorporate adjustments for a small number of cases in which we collect a recovery rate that differs from K&M. In several of these cases, our adjusted recovery rates are significantly higher than those computed by K&M, which causes the average recovery rate to increase to 36.59%.[15] Next, we present the mean for the subsample that has data available on Compustat. The mean drops slightly to 36.00%. We then limit the sample to only those observations with a non-missing P&T off-balance-sheet intangibles estimate on WRDS. The mean increases to 38.13%. Finally, we incorporate the P&T estimate of off-balance-sheet intangibles into the denominator of the recovery rate. At this step, we also incorporate recovery rates for firms with no reported intangible book values and/or recoveries, but positive off-balance-sheet intangibles, setting them to zero. This leads to an increase in the sample size to 327 observations and a significant drop in the mean industry recovery rate to only 2.85%.[16]

[15] We follow K&M in continuing to omit one unusual case from the book recovery rates. The liquidation analysis for Foreland Corporation lists a recovery of $50,000 for intangibles with a book value of $1, implying a book recovery rate of 5,000,000%. The P&T estimate of off-balance-sheet intangibles for Foreland Corporation prior to bankruptcy is $2,011,000. Thus, our adjusted recovery rate is only 2.85%, and we re-include this recovery rate at Step 5. This case highlights the shortcomings of using book recovery rates. The ad hoc omission of extreme outliers is unlikely to be an effective solution.

[16] As a robustness check (untabulated), we also re-estimate our adjusted intangible recovery rates after including both recoveries from "other long-term assets" and the corresponding book values of these assets in the numerator and denominator, respectively. This adjustment modestly increases our average intangible recovery rate from 2.85% to

For comparative purposes, we also provide the average recovery rate for our final 327 observations using K&M's original recovery rates (when available) with no adjustments. Using this sample and K&M's original rates, the average intangible recovery rate is 22.68%. The intuition behind this huge difference is that the original K&M recovery rates consist of some extremely high recovery rates for companies with large off-balance-sheet intangibles, but relatively small book intangibles. In such circumstances, even modest recoveries on off-balance-sheet intangibles lead to extremely high book recovery rates. Incorporating off-balance-sheet intangibles addresses this problem. Panel B of Table 4 presents descriptive statistics on the second moments of the industry-level recovery rates. Variability across industries is very high in the original K&M recovery rates and declines substantially once we incorporate the P&T estimates of off-balance-sheet intangibles into the recovery rates. For example, the maximum industry-level recovery rate for intangibles falls from 139.76% in K&M's sample to 36.70% after our adjustments.

The reduced average intangible recovery rates following our adjustments are far below those for PP&E. PP&E has an industry-level mean recovery rate of 35.00%, while the industry-level mean recovery rate for intangibles drops from 24.83% in K&M to 2.85% following our adjustments. To provide more detailed evidence, Figure 3 plots recovery rates for PP&E, intangibles, and nongoodwill intangibles by Fama-French 12-digit industry groups. Panel A uses K&M's original recovery rates, while Panel B uses our adjusted intangibles recovery rates. Moving from K&M's rates to our adjusted rates reveals a sharp decline in intangibles recovery rates relative to PP&E recovery rates across nearly all industries. Interestingly, this decrease is not present for 'Utilities'. The reason is that Compustat has a policy of classifying most SG&A and R&D expenses for utilities under Cost of Goods Sold, such that the P&T estimates fail to capture their investments in off-balance-sheet intangibles. Figures 4 and 5 further illustrate this issue. Figure 4 plots the ratio of book intangibles to total intangibles (i.e., on- and off-balance-sheet intangibles) by Fama-French 12-digit industry groups, both equal- and value-weighted. In both panels, the results indicate that utilities

3.82%. We conduct this robustness test because several liquidation analyses provide descriptive notes indicating that intangible assets are sometimes included in the "Other Assets" line item. For example, in the liquidation analysis of Gardenburger Inc., the firm reported $326,000 in book value for other long-term assets and an associated recovery rate of 2,042.9% when deflating by book intangibles. Upon reviewing the liquidation notes, we find that this line item included recoveries for trademarks, as professional fees related to trademarks were capitalized within other assets.

have nearly 100% of their intangibles appearing on the balance sheet. Figure 5 complements this finding by plotting the proportion of firm-years with missing or zero values of P&T off-balance-sheet intangibles by Fama-French 12-digit industry groups. Outside of utilities, over 80% of firm-years have positive off-balance-sheet intangible values, but for utilities, only about 5% have positive values.[17] The absence of P&T off-balance-sheet intangibles for utilities explains the high book intangible proportions in Figure 4 and the high adjusted utility intangible recovery rates in Figure 3.

Finally, we detail the original and adjusted intangible recovery rates by two-digit SIC codes in Table 5. The first two columns present K&M's original industry-level recovery rates and use asterisks to signify whether the recovery rates are significantly different from the sample-wide recovery rate when excluding that industry. The next two columns present our recovery rates that have been adjusted for off-balance-sheet intangibles. The recovery rates drop sharply, with all the industries in which K&M's recovery rates exceeded 100% dropping well below this threshold. The only remaining industries with intangible recovery rates exceeding 10% are 'Electric and Gas' at 37% and 'Transportation by Air' at 25%. Importantly, these are two industries in which we believe that the P&T adjustments for off-balance-sheet intangibles are materially understated. 'Electric and Gas' corresponds to the utilities industry discussed above, where firms often have zero P&T off-balance-sheet intangibles due to Compustat data classification policies. 'Transportation by Air', as highlighted in Section 2, involves large investments in intangibles such as routes, gates and slots that are classified by Compustat under 'Cost of Goods Sold'. We also observe a similar classification issue in 'Communications'. Thus, we believe that our adjusted rates continue to significantly overstate actual recovery rates in these three industries.[18] Finally, no other industries have an average recovery rate that differs significantly from the sample-wide mean. Thus, we conclude that intangible recovery rates are small and exhibit little systematic inter-industry variation.

### 4.2 Implied Recovery Values

Having shown that our adjusted intangible recovery rates are substantially lower than K&M's, we

[17] Discussions with Compustat product support specialists confirmed that for utilities, Compustat generally classifies all operating expenditures, including selling general and administrative expense and research and development expenditures in cost of goods sold.

[18] We revisit this issue in Section 5.1.

next assess how the use of these revised rates affect inferences about implied firm-level liquidation values. We begin by analyzing liquidation values for the bankruptcy sample used to calculate K&M's recovery rates and then, following K&M, apply these rates to the Compustat universe. Using estimated recovery rates that omit off-balance-sheet intangibles leads to errors in estimated recovery values. We can quantify these errors in the bankruptcy sample by calculating the difference between the actual dollar-value recovery for intangibles in each bankruptcy firm's liquidation analysis and the estimated recovery value obtained by applying either K&M's original or our adjusted industry-level recovery rates to each firm's intangibles using the same 'hold one out' approach as in Section 3. Specifically, for each firm in our final sample of 327 bankruptcy observations, we re-estimate K&M's original and our adjusted industry average recovery rates after excluding the firm itself from the respective industry average.

When using the K&M rates, we follow their approach of multiplying nongoodwill intangibles by the nongoodwill intangible recovery rates, if available. If missing, we multiply the combined intangibles value by the combined intangibles recovery rate. If nongoodwill intangibles and the combined intangibles value are both missing, the estimated recovery is set equal to zero. Because we cannot distinguish between goodwill and nongoodwill off-balance-sheet intangible assets, we apply our rates differently. When using our adjusted rates, we estimate recoveries by summing non-missing amounts for book goodwill, book nongoodwill intangibles, and P&T off-balance-sheet intangibles and multiplying by our adjusted intangibles recovery rate.[19] We scale all errors by the sum of the total book value of assets from the liquidation analysis plus the P&T off-balance-sheet intangibles. This analysis is then repeated after replacing the industry-level recovery rates with sample-wide average recovery rates, again excluding each individual firm's recovery rate from its respective sample-wide average.

Table 6 reports descriptive statistics on the scaled errors, their absolute values, and their squared values. Using K&M's recovery rates, the mean prediction error is -0.009, with a mean absolute error of 0.023, and a mean squared error of 0.006. The negative mean error indicates that

[19] A concern with this approach is that it implicitly assumes that recovery rates on book intangibles and off-balance-sheet intangibles are the same. We revisit this issue and conduct additional robustness tests in Section 5.4.

K&M's rates, on average, overstate intangible liquidation recovery values. In contrast, applying our adjusted rates yields a mean error of 0.001, a mean absolute error of 0.021, and a mean squared error of 0.002. The slightly positive mean error suggests a mild understatement of intangible recoveries, while the smaller mean absolute and mean squared errors show that our adjusted recovery rates generate more accurate predictions of recoveries. When comparing the errors calculated using sample-wide versus industry-level recovery rates, the mean absolute and squared errors are smaller when using K&M's recovery rates and relatively unchanged when using our adjusted recovery rates. These results corroborate our earlier findings that inter-industry variation in the K&M recovery rates is primarily attributable to sampling error.[20]

The results in Table 6 confirm that K&M's recovery rates tend to significantly overstate recoveries for firms with positive book intangibles, leading to some large negative prediction errors. Furthermore, while our adjusted rates generate more accurate predictions, they appear to be slightly downwardly biased for firms with positive book intangibles and slightly upwardly biased for firms without book intangibles (untabulated). One explanation for these findings is that recovery rates for book intangibles are greater than those for off-balance-sheet intangibles. This would be the case if off-balance-sheet intangibles were mostly 'off-balance-sheet goodwill' with little recovery value. Another explanation is that when a firm has no book intangibles and only minor expected recoveries for off-balance-sheet intangibles, these minor recoveries are omitted from the liquidation analyses. This will cause our recovery rates to be understated, because we set the associated recovery values to zero. We revisit these issues in Section 5.4.

We now move on to analyze the application of these recovery rates to Compustat firms from 1990 to 2018. K&M use this analysis to demonstrate that the growing prevalence of intangibles has not significantly reduced aggregate implied liquidation recovery values. We seek to determine whether their results are robust to the use of recovery rates incorporating off-balance-sheet intangibles. Table 7 begins with summary statistics on book intangibles, nongoodwill book

[20] Because the errors in Table 6 are similar in size or smaller when using a sample-wide average recovery rate to calculate intangible liquidation values, we also recreate Figure 6 using the sample-wide intangibles recovery rate rather than the industry-level rates. Our adjusted sample-wide recovery rate for combined book and off-balance-sheet intangibles is 3.27%. Results for Figure 6 (not reported) are qualitatively unchanged when using this sample-wide rate.

intangibles, and P&T estimates off-balance-sheet intangibles in the Compustat universe. The analysis in Section 2.4 establishes that biases in the estimated recovery values depend on the distributional properties of these variables. Panel A shows that book intangibles average 10% of total book and off-balance-sheet assets, nongoodwill book intangibles average 5% of total book and off-balance-sheet assets, and off-balance-sheet intangibles average 32% of total book and off-balance-sheet assets. Similarly, the standard deviation for off-balance-sheet intangibles is larger than that for book intangibles. Thus, the off-balance-sheet intangibles that are omitted by K&M are relatively significant. We also create two indicator variables, *Book Intan Indicator* and *NGW Book Intan Indicator,* that take the value of 1 when the designated intangible is nonzero, and zero otherwise. *Book Intan Indicator* has a mean value of 0.60, and *NGW Book Intan Indicator* has a mean value of 0.32. Recall that K&M assign expected recoveries of zero to firms with missing book intangibles even though they may have recoveries on off-balance-sheet intangibles.

Panel B of Table 7 presents simple pairwise correlations between the variables in Panel A. Recall from Section 2.4 that a positive correlation between book and off-balance-sheet intangibles will attenuate the upward bias in K&M's estimated recoveries. In practice, however, the correlation is negative.[21] Finally, Ln(*Enterprise Value*), a measure of firm size, is positively correlated with book intangibles, but negatively correlated with off-balance-sheet intangibles. Of particular note, the correlation between Ln(*Enterprise Value*) and *Book Intan Indicator* is 0.25. This correlation indicates that large firms are significantly more likely to have book intangibles. These descriptive statistics have two important implications for expected biases in the Compustat universe:

(i) K&M's approach will tend to overstate recovery values for large firms, because large firms have a relatively high proportion of book intangibles.

(ii) K&M's approach will tend to understate recovery values for small firms, because small firms have a relatively low proportion of book intangibles, with many having no book intangibles at all.

[21] One reason for the documented negative correlation is the adding up constraint that all asset categories must sum to 100%. This means that, ceteris paribus, a higher proportion of book intangibles implies a lower proportion of off-balance-sheet intangibles. Consistent with this reasoning, when we recompute the correlations deflating asset categories by enterprise value (untabulated), the correlations become mildly positive.

With an understanding of these potential biases, we now replicate K&M's analysis examining how rising intangibles affect time trends in aggregate liquidation values. First, we apply K&M's industry-level recovery rates to each asset category for all non-financial firms on Compustat from 1990 to 2018. We then repeat this analysis using our revised recovery rates for intangibles, along with the same recovery rates as K&M for other asset categories. This analysis is shown in Figure 6. Panel A replicates K&M's Figure II, calculating intangible liquidation values as book intangibles minus goodwill multiplied by the nongoodwill intangibles recovery rate for that industry. If goodwill is missing, they instead multiply total book intangibles by the combined intangibles recovery rate for that industry. If total intangibles are missing, a liquidation value of zero is assumed. The results show that while recoveries for working capital and PP&E have declined between 1990 and 2016, recoveries for cash and intangibles have increased. Importantly, estimated recoveries from intangibles increased from 2.1% of assets to 4.6% of assets between 1990 and 2016. Thus, when using K&M's recovery rates, the growing prevalence of intangible assets has not significantly reduced firms' liquidation values. However, this result arises in part because (i) the K&M recovery rates for intangibles are upwardly biased and (ii) the book values of these intangibles have increased over the sample period.

Panel B of Figure 6 uses our revised recovery rates. As in Table 6, we estimate recoveries by applying our adjusted industry-level recovery rates from Table 5 to the sum of book intangibles and the estimated P&T off-balance-sheet intangibles. We then deflate recoveries for all asset classes by the sum of total book assets and P&T off-balance-sheet intangibles, requiring non-missing P&T estimates for observations to be included in the analysis.[22] Using our revised methodology, book intangible recovery values are much lower and increase from only 0.6% to 1.7% over the sample period. Meanwhile, recoveries from non-cash working capital and PP&E decline substantially, resulting in a large decline in non-cash liquidation values and a modest decline in aggregate liquidation values over the sample period. Overall, non-cash liquidation values fall from 28.2% in 1990 to 19.6% in 2016, while total liquidation values decline from 31.8% in 1990 to 28.7% in

[22] Note that K&M also make this deflator adjustment in Figure 1 of their Online Appendix, but they don't make the deflator adjustment to their recovery rates. Hence, they continue to see a stable time trend in firm-level recoveries.

2016. These results are consistent with the model in Falato et al. (2022) in which firms with high intangibles hold more cash in order to offset the reduced borrowing capacity arising from the lower liquidation values of intangibles.

Next, Panels C and D replicate the analysis in Panels A and B using enterprise value as an alternative deflator. This is the same deflator that K&M apply to the Compustat sample in their Table III, where they refer to it as the 'going-concern value'. The advantage of using this deflator is that it incorporates the market-assessed value of off-balance-sheet intangibles, providing a direct assessment of the proportion of going concern value that can be recovered in liquidation. We omit any firms with missing enterprise values from both Panels C and D and omit firms with missing P&T values from Panel D. The use of this alternative deflator shows a significant decline in liquidation values regardless of whether we use the original K&M recovery rates in Panel C or our revised recovery rates in Panel D. The key takeaway from these graphs is that when using our adjusted recovery rates, firms' implied recovery values have declined significantly relative to their going concern values between 1990 and 2016. During this period, investments in non-cash working capital and PP&E have declined, while investments in intangibles have increased. Combined with the significantly lower liquidation recovery rates for intangibles, this has led to significant declines in non-cash liquidation recoveries. For example, Panel D shows that non-cash liquidation recoveries fall from 39.9% of enterprise value in 1990 to 20.7% in 2003 and just 16.0% in 2016. Meanwhile, cash recoveries show only slight increases, such that firm-level recoveries also decline. Thus, in contrast to K&M, our revised analysis shows that the growing prevalence of intangibles has led to substantial reductions in liquidation recovery values.

### 4.3 Tests of Economic Theories

K&M motivate their analysis by noting that asset specificity underpins several prominent economic theories. With regard to financing decisions, highly specific assets provide poor collateral value for debt financing, resulting in lower debt capacity (Titman and Wessels, 1988) and higher cash holdings (Falato et al., 2022). With regard to organizational structure, highly specific assets are better suited to vertically integrated organizations (Williamson, 1996). If our revised recovery rates more accurately measure asset specificity, they should yield more powerful

tests of these theories. To investigate whether this is the case, we examine the relation between each set of recovery rates and proxies for debt capacity, cash holdings, and vertical integration. Under the joint hypothesis that the underlying economic theories hold and our revised recovery rates more accurately measure asset specificity, we expect to find stronger empirical support using our revised rates.

Our tests employ empirical proxies for each of three constructs underlying the economic theories relating to asset specificity. First, we use financial leverage (the ratio of debt to assets) to measure debt capacity. Firms with higher recovery rates should have greater debt capacity, leading to a positive relation between leverage and recovery rates. Second, we use the relative size of the cash balance (ratio of cash to assets) to measure cash holdings. Firms with higher recovery rates should require less of a cash buffer, leading to a negative relation between the cash balance and recovery rates. Third, following Adelman (1955), we use the ratio of value added to sales to proxy for vertical integration. We use gross profit as the measure of value added and hence gross margin (ratio of gross profit to sales) to measure the degree of vertical integration. Firms with higher recovery rates have less benefit from vertically integrating, leading to a negative relation between gross margin and recovery rates.

To test the economic theories linking asset specificity to firm-level characteristics, we require an overall measure of asset specificity that sums across all categories of each firm's operating assets. We don't include cash in this measure, because cash is treated as an endogenous variable that is determined by management in response to the specificity of their non-cash operating assets. We therefore focus on non-cash recovery rates—which sum across receivables, inventory, PP&E, and intangibles. When calculating non-cash recoveries, we use the same two-digit industry-average recovery rates described in Section 4.2 and apply them to the same Compustat sample of firm-years described in Section 4.2. The combined firm-year *K&M Non-Cash Recovery Rate* is calculated as follows:

$$K\&M\ Non\text{-}Cash\ Recovery\ Rate_{j,t} =$$

$$RecoveryReceivableMid_I * (Receivables_{j,t} / Non\text{-}Cash\ Book\ Assets_{j,t}) +$$

$$RecoveryInventoryMid_I * (Inventory_{j,t} / Non\text{-}Cash\ Book\ Assets_{j,t}) +$$

$$RecoveryPPEMid_I * (Net\ PP\&E_{j,t} / Non\text{-}Cash\ Book\ Assets_{j,t}) + RecoveryIntanMid_I * (Book\ Intangibles_{j,t} / Non\text{-}Cash\ Book\ Assets_{j,t}) \quad (4)$$

where *RecoveryReceivableMid* is K&M's recovery rate for accounts receivable for industry I, *Receivables* is accounts receivable for firm j in year t, *Non-Cash Book Assets* is Compustat total assets minus cash and cash equivalents for firm j in year t, *RecoveryInventoryMid* is K&M's recovery rate for inventory for industry I, *Inventory* is the inventory balance for firm j in year t, *RecoveryPPEMid* is K&M's industry-level recovery rate for PP&E, *Net PP&E* is the net PP&E balance for firm j in year t, *RecoveryIntanMid* is K&M's recovery rate for intangibles, and *Book Intangibles* is the on-balance-sheet intangibles reported in Compustat.[23]

When calculating *Our Non-Cash Recovery Rates*, we replace K&M's intangible recovery rate with our adjusted rate and add P&T off-balance-sheet intangibles to the intangible value to which the recovery rate is applied. Importantly, we also deflate each asset category by the sum of *Non-Cash Book Assets* and P&T off-balance-sheet intangibles (rather than just *Non-Cash Book Assets*). The use of this revised deflator is important, because it shrinks the recovery rates for firms that make significant investments on internally generated intangibles.

We next test each of the economic theories by estimating regressions of the following form:

$$Firm\ Characteristic_I = \beta_0 + \beta_1 * Non\text{-}Cash\ Recovery\ Rate_I + \varepsilon \quad (5)$$

where *Firm Characteristic* represents either *Leverage, Cash,* or *Gross Margin*, and *Non-Cash Recovery Rate* represents the industry's estimated overall recovery rate using either K&M's original rates or our adjusted rates. In regressions using K&M rates, *Leverage* is calculated as the sum of short- and long-term debt scaled by Compustat total assets, multiplied by 100, while *Cash* is calculated as cash and cash equivalents scaled by Compustat total assets, multiplied by 100, and *Gross Margin* is calculated as sales minus cost of goods sold, scaled by sales and multiplied by 100. In regressions with our adjustments, the dependent variables *Leverage* and *Cash* are scaled by the sum of Compustat total assets and P&T off-balance-sheet intangibles.

[23] For the intangibles portion of the calculation, when calculating K&M's rates, we follow K&M in calculating intangible liquidation values as book intangibles minus goodwill multiplied by the nongoodwill intangibles recovery rate for that industry. If goodwill is missing, we instead multiply total book intangibles by the combined intangibles recovery rate for that industry.

In each regression, all variables are first calculated at the firm-year level and then averaged within two-digit SIC. We average observations at the industry level for two reasons. First, our underlying asset-level recovery rates are based on industry averages, making industry a good instrument for alleviating errors that can arise at the firm-level when the underlying firm-level recovery rates differ from the industry average. Second, while we estimate firm-level recovery rates for each year in our sample period, these rates are highly serially correlated, and averaging across time addresses this issue. Finally, we exclude three industries with Compustat classification issues for P&T off-balance-sheet estimates as identified at the end of Section 4.1.[24]

Table 8 presents the industry-level regressions of non-cash recovery rates on the three firm characteristics. We present the results in three panels that differ with respect to the recovery rates used for intangibles. Panel A excludes intangibles from the non-cash recovery rate calculation entirely (i.e., assumes an intangible recovery rate of zero), Panel B uses industry-level intangible recovery rates, and Panel C uses the sample-wide average intangible recovery rate. This three-panel structure allows us to assess how the incorporation of off-balance-sheet intangibles facilitates more powerful tests of the economic theories. Note that while Panel A assumes that there are no recoveries on intangibles, the regressions using "K&M Recovery Rates" deflate recoveries by book assets, while the regressions using "Our Recovery Rates" deflate recoveries by the sum of book assets and the P&T estimates of off-balance-sheet intangibles. Thus, K&M's rates should be overstated, particularly in industries making large investments in off-balance-sheet intangibles, and our rates should mitigate these overstatements.

The results in Panel A provide mixed support when using K&M's rates. The relation between *Leverage* and non-cash recovery rates is insignificant, while *Gross Margin* is only marginally significant. In contrast, when using our recovery rates, all coefficients are highly statistically significant and of the hypothesized sign. Additionally, the R-squared values are much larger using our recovery rates. These results highlight that investments in off-balance-sheet intangibles are significant, and it is important to include these investments in the denominator of the overall firm-

[24] In untabulated analyses, we find similar results when including the three industries. Additionally, when running results at the firm-year level (rather than the industry-level), coefficients when using K&M's rates are insignificant in all columns, while results using our rates remain significant.

level recoveries when testing theories relating to asset specificity.[25]

Panel B reruns these regressions after including recoveries on intangible assets that are estimated using the industry-level recovery rates from the bankruptcy sample. Recall from Section 4.2 that the K&M industry-level recovery rates provide particularly biased and inaccurate estimates of actual recoveries. In the regressions using K&M's rates, the relation with *Gross Margin* becomes insignificant and the R-squareds all decline relative to Panel A. When using our adjusted rates, while all coefficients remain highly significant, we see slight reductions in all coefficient magnitudes and R-squared values relative to Panel A. These results suggest that industry-level intangible recovery rates are dominated by noise rather than systematic inter-industry variation in recoveries, consistent with our previous results in Table 2 and Table 6.

Finally, Panel C reruns the regressions after including recoveries on intangible assets that are estimated using the sample-wide recovery rate from the bankruptcy sample. Recall from Table 6 that the use of a sample-wide recovery rates helps to alleviate errors in the estimated K&M recoveries. The results in Panel C are nearly identical to those in Panel A. These results reflect the practical reality that recoveries on intangible assets are negligible, so assuming that they are zero delivers similar results to using a sample-wide average recovery rate that is very small.

Overall, these results reinforce our earlier findings from Table 2 and Table 6 that cross-industry variation in intangible recovery rates largely reflects sampling error. Additionally, the significantly greater explanatory power of our adjusted rates relative to K&M's rates—even in Panel A with no intangibles recoveries assumed—provides evidence that while the intangible recoveries themselves are negligible, investments in off-balance-sheet intangibles are significant, making it important to include them in the denominator of the estimated overall firm-level recoveries.

## 5 Other Potential Sources of Estimation Error

Our analysis thus far focuses on the impact of including estimates of off-balance-sheet

[25] Because the variables in the regressions using K&M's rates and our adjustments are different (i.e., scaled by different deflators), we cannot directly compare coefficient magnitudes. Instead, we compare significance of the coefficients and the reported R-squared values.

intangibles in liquidation recovery rate calculations. Nevertheless, even our adjusted recovery rates appear to be subject to considerable estimation error. This section highlights four potential sources of error: (i) errors in the estimation of internally-generated intangibles, (ii) errors in book intangibles that are introduced by asset impairment rules, (iii) errors in book intangibles associated with the use of pooling accounting early in the sample period, and (iv) differences between book and off-balance-sheet intangible asset recovery rates.

### 5.1 Errors in the Estimation of Off-balance-sheet Intangibles

Peters and Taylor (2017) highlight that their estimates of off-balance-sheet intangibles are based on strong assumptions that may not reflect reality. To alleviate concerns that their results are driven by unrealistic assumptions, they conduct extensive robustness tests using a wide range of intangible investment capitalization and amortization assumptions. A cursory analysis of our adjusted recovery rates suggests that some continue to be overstated due to omitted off-balance-sheet intangibles. As previously discussed in Section 2, investments in intangibles are often recorded under the 'Cost of Goods Sold' line item on Compustat and hence omitted from the P&T estimates. This can happen for two reasons. First, many investments in intangibles naturally run through cost of goods sold. Examples include an assembled workforce for manufacturers, emissions credits for utilities, and slots, gates & routes for airlines. Second, Compustat classifies expenses related to R&D and SG&A activities in Cost of Goods Sold for firms in certain industries. Through discussions with Compustat, we were able to establish that this is done intentionally for utilities, though we also find examples of companies in other service industries where this practice appears to have been followed.

We illustrate the impact of these errors through six examples in K&M's bankruptcy sample. After adjusting recovery rates for the P&T estimates of off-balance-sheet intangibles, the following six outliers with intangibles recovery rates exceeding 40% still remain:

| **Company (Industry)** | **Adjusted Intangibles Recovery Rate** | **Possible Sources of Error in P&T Estimate** |
|---|---|---|

| | | |
|---|---|---|
| Energy Future Holdings Corp. (Electric and Gas) | 88% | Compustat classifies all Selling, General, & Administrative Expenses in Cost of Goods Sold. Also, intangibles include environmental allowances and credits that require investments in operating expenses that are also classified in Cost of Goods Sold. |
| Northwest Airlines Corporation (Transportation by Air) | 88% | Compustat classifies all Selling, General, and Administrative Expenses in Cost of Goods Sold until 2002 (P&T amount used is from 2004). Also, the main intangibles are 'International Route Authorities' that require investments in operating expenses that are also classified in Cost of Goods Sold. |
| AMR Corporation (Transportation by Air) | 83% | Compustat classifies all Selling, General, and Administrative Expenses in Cost of Goods Sold until 2003 (P&T amount used is from 2010). Also, the main intangibles are 'Routes, Airport Slots & Gate Costs' that require investments in operating expenses that are also classified in Cost of Goods Sold. |
| Delta Airlines (Transportation by Air) | 67% | Compustat classifies all Selling, General, and Administrative Expenses in Cost of Goods Sold until 2003 (P&T amount used is from 2004). Also, the main intangibles are 'International Routes and Domestic Slots' that require investments in operating expenses that are also classified in Cost of Goods Sold. |
| GenOn Energy, Inc. (Electric and Gas) | 59% | Compustat classifies all Selling, General, & Administrative Expenses in Cost of Goods Sold. Also, intangibles include emissions allowances and credits that require investments in operating expenses that are also classified in Cost of Goods Sold. |
| Granite Broadcasting Corporation (Communications) | 47% | With the exception of one year (1990), Compustat classifies all Selling, General, & Administrative Expenses in Cost of Goods Sold. Also, the main category of intangible assets is 'broadcast licenses' that requires investments in operating expenses that are also classified in Cost of Goods Sold. |

In each of these six cases, Compustat has classified at least some of the previous years' SG&A expenses in Cost of Goods Sold. Also, in each of these cases, the main categories of intangible assets are generated by investments in operating costs that Compustat typically classifies in Cost of Goods Sold. Since Compustat's Cost of Goods Sold is not included in P&T's estimates of off-balance-sheet intangibles, these off-balance-sheet intangible investments will be omitted, leading to the understatement of off-balance-sheet intangible capital and the overstatement of recovery

rates.

### 5.2 Errors Introduced by Impairment Rules

Firms make investments with the intention of recovering their initial outlay plus a return on investment. Impairments occur when future investment returns are less than initially anticipated. Accounting rules require assets to be written down to fair value when book value exceeds an impairment threshold. Different impairment thresholds are used for different categories of assets. PP&E and finite-lived intangible assets (both of which are subject to periodic amortization) are impaired to fair value when their expected undiscounted future cash flows are less than book value. Indefinite-lived intangibles (which are not subject to periodic amortization) are impaired when their expected discounted cash flows are less than book value. Consequently, when the economic performance of an asset is significantly lower than expected, an impairment is recorded, causing the asset's book value to understate invested capital. Using these impaired book values to compute liquidation recovery rates will lead to upwardly biased recovery rates.

Impairments are likely to be prevalent around bankruptcies. Bankruptcies generally arise when the economic performance of a business is significantly lower than expected, which reflects the same conditions that trigger impairments. Thus, the book values of assets used in bankrupt firms' liquidation analyses are likely to have been subject to previous impairments, causing them to understate past investments and overstate the associated recovery rates. Applying these inflated recovery rates to healthy firms on Compustat—which have experienced fewer impairments—will then overstate expected recovery values for intangibles.

To assess the significance of impairments leading up to bankruptcies, Figure 7 plots average impairments (as a percentage of lagged total assets) in the fiscal quarters leading up to bankruptcy. Panel A presents results for K&M's sample of bankrupt firms that we can link to Compustat. We plot both raw impairments and abnormal impairments separately for nongoodwill impairments (Compustat item WDP) and goodwill impairments (Compustat item GDWLIP).[26] Abnormal impairments are calculated by subtracting the average percent of assets impaired by all firms on

[26] The Compustat Data Guide indicates that GWLIP includes (i) goodwill impairments, (ii) impairments of goodwill and other intangibles when combined, and (iii) impairments of unamortized intangibles.

Compustat in the corresponding fiscal quarter. The figure shows a sharp increase in impairments starting around eight quarters before bankruptcy, with impairment activity intensifying as bankruptcy approaches.

Panel B replicates this analysis for a broader sample of Compustat firms that are delisted with a CRSP delisting code of 574 (delisted by current exchange - bankruptcy, declared insolvent) from 1990 to 2018. These firms also display rising impairment activity in the quarters leading up to delisting, though the impairment magnitudes are somewhat smaller than for K&M's bankruptcy sample. Together, these findings suggest that pre-bankruptcy impairment activity will cause additional upward bias in estimated intangible recovery rates, reinforcing the need for caution when applying these rates to non-distressed firms, and indicating that additional adjustments may be necessary to correct for this bias.

To illustrate the potential impact of this bias, we provide a brief case study for the bankruptcy of Anvil Holdings Inc. This company has a nongoodwill recovery rate of 332%, representing the third highest nongoodwill recovery rate in K&M's original sample and driving K&M's highest overall industry-level recovery rate (166% for 'Textile Products').[27] K&M report that the liquidation analysis lists a combined intangibles line item of $1.6M with a mid-recovery rate of 50%. Since this is a combined item, K&M divide the recovery rate by the industry average proportion of nongoodwill intangibles (approximately 15%) to arrive at the implied nongoodwill intangible recovery rate of 332%. An issue with this computation is that Anvil's goodwill was impaired prior to bankruptcy. Anvil filed for bankruptcy in October 2006 and its annual financial statements on Form 10-K for the year ended January 2006 show an intangibles balance of $1.7M. Thus, the $1.6M shown in the liquidation analysis appears to be this amount less $0.1 of intervening amortization. The notes to the Form 10-K indicate that "the Company's remaining intangible assets, which are being amortized, consist of trademarks having an aggregate value of $4,858, less accumulated amortization of $2,860 and $3,146 as of January 29, 2005 and January

[27] The textile products industry has two bankruptcies with non-missing nongoodwill intangible recovery rates. The first is Anvil Holdings Inc. with a recovery rate of 332%. The second is Xerium Technologies, Inc. with a recovery rate of 0%. These two bankruptcies combine to generate the industry-average recovery rate of 166%. We are unable to locate a P&T off-balance-sheet intangibles value for Anvil Holdings Inc., so this bankruptcy is excluded from our adjusted sample.

28, 2006, respectively." This description highlights that the intangible balance does not, in fact, contain any goodwill. Furthermore, the company had been making losses since 2004 and wrote off its entire goodwill balance in 2004 through a goodwill impairment of $19.4M. Thus, in-line with the industry average, Anvil originally had a very small proportion of nongoodwill intangibles, but the losses precipitating its bankruptcy also precipitated the impairment of its entire goodwill balance. Taking the goodwill impairment into consideration, the book nongoodwill intangible recovery rate would have been only 50% instead of the 332% recorded by K&M. Adjusting for off-balance-sheet intangibles should further reduce the recovery rate.[28]

### 5.3 Errors Introduced by the Elimination of Pooling Accounting and Goodwill Amortization

Figure 2 shows that book intangibles have been increasing steadily over the last 30 years. One explanation for the steady increase in book intangibles is the elimination of the "pooling of interests" method of accounting for business combinations by SFAS 141 starting in 2002. Prior to 2002, firms could use the pooling-of-interests method for qualifying business combinations. This method essentially adds together the pre-existing book assets of the combining entities rather than determining a purchase price for the acquired entity and assigning it to the acquired assets. Prior research suggests that aggressive use of the pooling of interests method prior to 2001 caused a significant amount of acquired assets to be unrecognized. For example, Ayers, Lefanowicz and Robinson (2000) estimate that pooling acquisitions represented over 40% of all acquisitions by value during the 1992-1997 period and that over half of the purchase price on these acquisitions went unrecognized on acquirors' books. Additionally, Bartov, Cheng, and Wu (2021) find a similar proportion of pooling acquisitions up until 2001, with zero pooling acquisitions from 2002 onward.

The elimination of the pooling method means that post-2001 acquisitions are more likely to record purchased intangibles. Concurrent with the elimination of pooling in SFAS 141, SFAS 142

[28] Impairments also impact other asset categories, particularly PP&E. For example, Kermani and Ma's data contains several firms in the oil and gas production industry with PP&E liquidation recovery rates exceeding 100%. Closer inspection reveals that the underlying assets are oil and gas properties that were subject to large impairments following sharp reductions in oil and gas prices. These price reductions forced the firms into bankruptcy, but oil and gas prices had rebounded somewhat by the time of bankruptcy, resulting in recovery rates exceeding 100% of the previously impaired values.

also eliminated the amortization of goodwill and other indefinite-lived intangibles, replacing it with a periodic fair-value-based impairment test at the business unit level. Since many acquirors have significant pre-acquisition off-balance-sheet intangibles at the time of an acquisition, they have 'pre-acquisition headroom' that buffers the business unit against subsequent impairment-based reductions (see Linsmeier and Wheeler, 2021). Both accounting changes should cause book-intangibles to increase over the sample period. Note that because acquisitions lead to intangibles that can remain on the books for many years, this increase should continue throughout the sample period.

While it is difficult to estimate the magnitude of this accounting change on liquidation recovery rates and values, we can sign its impact. First, omissions of purchased intangibles from balance sheet in the early part of the sample period will cause liquidation recovery rates from bankruptcies earlier in the sample period to be overstated. This will lead to an overstatement in the industry-level average recovery rates estimated across the entire sample. Second, applying these overstated average recovery rates to firms on Compustat will lead to greater overstatements in liquidation recovery values later in the sample period, when more purchased intangibles are recorded on the books. This should cause a mechanical increase in the estimated recoveries reported in Figure 6.

### 5.4 Differences Between Book and Off-balance-sheet Intangible Asset Recovery Rates

In adjusting K&M's liquidation recovery rates for estimates of off-balance-sheet intangibles, we assume that (i) bankruptcy liquidation analyses consistently incorporate expected recoveries for off-balance-sheet intangibles, and (ii) expected recovery rates on book intangibles and off-balance-sheet intangibles are the same. In practice, both assumptions may be violated.

With respect to assumption (i), we do observe some liquidation analyses that report dollar intangible recoveries while having no intangibles on the books. Thus, we can confirm that recoveries of off-balance-sheet intangibles are not completely ignored. However, given the low recovery rates on intangibles, it seems possible that if a firm has no book intangibles and only minor expected recoveries for off-balance-sheet intangibles, such minor recoveries may be omitted from the liquidation analysis. This will cause our recovery rates to be understated, because we set the associated recovery values to zero. This possibility is consistent with a cursory analysis of the data. K&Ms original sample contains 211 observations with positive book intangibles, of which

141 (67%) are assessed to have positive recovery rates. Using our revised rates, we have 327 observations with positive P&T estimates of off-balance-sheet intangibles, of which only 113 (35%) are assessed to have positive recovery rates. This suggests that either many positive expected recoveries for off-balance-sheet intangibles are not included, or that off-balance-sheet intangibles simply have a lower frequency of positive expected recoveries.

With respect to assumption (ii), there are valid reasons why recovery rates for book intangibles and off-balance-sheet intangibles could differ. For example, book intangibles are valued by allocating purchase prices from acquisitions, while off-balance-sheet intangibles are valued by accumulating past investments. The analyses in Figure 6 and Table 6 using our adjusted recovery rates that aggregate book intangibles and off-balance-sheet intangibles implicitly assume that their expected recovery rates are the same. To determine whether this is the case, Table 9 presents OLS regressions of realized recoveries on different categories of intangible assets. Specifically, we estimate the following three regressions for the liquidation analysis sample:

$$\textit{Intangible Recovery}_i = \beta_0 + \beta_1 * \textit{Book Intan}_i + \beta_2 * \textit{Off-BS Intan}_i + \varepsilon \quad (6)$$

$$\textit{Intangible Recovery}_i = \beta_0 + \beta_1 * \textit{NGW Book Intan}_i + \beta_3 * \textit{Book GW}_i + \beta_3 * \textit{Off-BS Intan}_i + \varepsilon \quad (7)$$

$$\textit{Intangible Recovery}_i = \beta_0 + \beta_1 * \textit{NGW Book Intan}_i + \beta_3 * \textit{Book GW}_i + \beta_3 * \textit{Off-BS Know}_i + \beta_4 * \textit{Off-BS Org}_i + \varepsilon \quad (8)$$

where *Intangible Recovery* is the estimated mid-point recovery value for intangible assets from the bankruptcy liquidation analysis, *Book Intan* is the value of book intangibles, *Off-BS Intan* is the estimate of off-balance-sheet intangibles using the P&T procedure, *NGW Book Intan* is the book value of nongoodwill intangibles, *Book GW* is the book value of goodwill , *Off-BS Know* is the estimated value of off-balance-sheet intangibles from R&D using the P&T procedure, and *Off-BS Org* represents the estimated value of off-balance-sheet intangibles from SG&A using the P&T procedure. All variables are scaled by the sum of the total book value of intangibles in the liquidation analysis and P&T off-balance-sheet intangibles. We also exclude observations in the Transportation by Air, Communications, and Electric and Gas industries as Section 5.1 indicates that firms in these industries can have significantly understated estimates of off-balance-sheet intangibles.

The regressions in Columns (1) and (2) of Table 9 estimate equations (6) and (7), respectively, using K&M's original recoveries and book values. To be included in these regressions, observations must be in our final sample of 327 bankruptcy observations, they must not be in the industries identified above, and they must have a K&M recovery rate. The regression in Column (1) shows a coefficient estimate of 5.6% on *Book Intan*, indicating that an additional $1 of *Book Intan* leads to an additional $0.056 of recoveries. The regression also has a significantly positive coefficient on *Off-BS Intan* of 3.2%, indicating that an additional $1 of *Off-BS Intan* leads to an additional $0.032 of recoveries. Thus, book intangibles have recovery rates about twice as high as off-balance-sheet intangibles (though the difference in coefficients is not statistically significant). The regression in Column (2) then separates *Book Intan* into its nongoodwill and goodwill components. *NGW Book Intan* has highly statistically significant coefficient of 13.4%, while *Book GW* has a coefficient that is insignificantly different from zero. This confirms that recoveries for book intangibles come from nongoodwill intangibles. Thus, the lower coefficients on off-balance-sheet intangibles could arise because they comprise a greater proportion of goodwill-related intangibles.

Next, Columns (3) and (4) of Table 9 estimate equations (6) and (8) using our adjusted recoveries. To be included in these regressions, observations must be in our final sample of 327 bankruptcy observations and they must not be in the industries identified earlier. This sample is larger than the K&M sample, because it includes many observations that don't have book intangibles (and hence don't have a K&M recovery rate) but do have off-balance-sheet intangibles. The results in Column (3) are similar to those in Column (1), but the estimated recovery on *Off-BS Intan* drops from 3.2% to 2.1%. This is because our adjusted sample includes many additional observations with positive off-balance-sheet intangibles, but no recoveries.[29] The final regression in Column (4) separates off-balance-sheet intangibles into those from capitalizing either R&D expenditures (*Off-BS Know*) or SG&A expenditures (*Off-BS Org*). R&D expenditures are hypothesized to create more nongoodwill intangibles than SG&A, and so we expect the coefficient

[29] The difference in the coefficients on *Book Intan* and *Off-BS Intan* in this column is statistically significant at the $p < 0.01$ level.

on *Off-BS Know* to be higher than that on *Off-BS Org*. The results support this hypothesis, with a coefficient on *Off-BS Know* of 3.4% and a coefficient on *Off-BS Org* of only 1.4%.

The procedures used to estimate our adjusted recovery values in Table 6 and Figure 6 assume that expected recovery rates on book intangibles (inclusive of goodwill) and off-balance-sheet intangibles are the same. Yet the regressions in Table 9 suggest that recovery rates on off-balance-sheet intangibles are lower. This will cause our estimated recovery values to be understated for firms with relatively high book values and overstated for firms with relatively high off-balance-sheet intangibles. As a robustness test, we replicate Figure 6 using the coefficients from Column (3) of Table 9 as sample-wide recovery rates for book intangibles and off-balance-sheet intangibles, respectively. The results (not reported) are qualitatively very similar to those reported in Panels B and D of Figure 6. Thus, as a practical matter, our results are not sensitive to the estimated differences in the recovery rates on book and off-balance-sheet intangibles.

### 5.5 Overall Impact of Errors

For the most part, the errors identified in this section cause our adjusted recovery rates to be upwardly biased. Thus, correcting these errors should further reinforce our key findings that (i) K&M's intangible recovery rates are overstated by an order of magnitude, and (ii) the growing prevalence of intangibles has led to reductions in firms' liquidation values. Nevertheless, even our adjusted industry-level recovery rates likely contain significant estimation error. To calibrate the impact of this error, we replicate the analysis in Panel B of Table 2 using our adjusted rates. This analysis regresses the recovery rates for each firm on the industry-average recovery rates using all other firms in the industry. The results (not reported) are mixed. When we include all industries, the results are significant with beta coefficients on intangibles ranging from 0.577 to 0.656. However, when we exclude the three industries identified to have systematically overstated recovery rates ('Electric and gas', 'Transportation by air' and 'Communications'), the beta coefficients on intangibles decrease to values between 0.236 and 0.302 and become only marginally statistically significant. Thus, we caution against using our adjusted recovery rates to model inter-industry variation in intangible recovery rates.

# 6 Conclusion

Intangibles capture an important and growing class of assets, making it critical to understand their specificity. Early research maintains that intangible assets have extremely high specificity, making them more risky and less suitable for secured borrowings. More recently, Kermani and Ma (2023) provide a comprehensive analysis of asset liquidation values using bankruptcy liquidation analyses, finding that nongoodwill intangibles have similar recovery rates to PP&E. Using these recovery rates, they show that growth in book intangibles and concurrent reductions in non-cash working capital and PP&E do not appear to have significantly reduced firm-level liquidation values.

We show that K&M's recovery rates are overstated, because the numerators include recoveries from both book and off-balance-sheet intangibles, while the denominators include only book intangibles. Moreover, the application of these recovery rates to other firms leads to upwardly biased estimates of expected intangible liquidation values, creating the impression that firm-level liquidation values have not declined with the increasing prevalence of intangibles. This bias arises because errors in the denominator cause the expected value of the ratio to exceed the ratio of the expected values of the numerator and denominator (see Jensen, 1906).

We revisit K&M's analysis of intangible asset recovery rates with one major adjustment—incorporating estimates of investment in off-balance-sheet intangibles in the computation of liquidation recovery rates. After incorporating these estimates, we find that intangible asset recovery rates drop by an order of magnitude and that the growing prevalence of intangible assets has been associated with reductions in firm-level liquidation recovery values. We also find that economic theories relating asset specificity to organizational structure, investment policy, and capital structure are strongly supported when using our adjusted rates.

Our results have implications for common corporate policy decisions. We establish that investments in intangibles have extremely high specificity. With regard to organizational structure, the high specificity of intangible assets suggests they are better suited to vertically integrated organizational structures or long-term contractual arrangements (Williamson, 1996). With regard to investment decisions, intangible assets have low value if their intended use case

fails, thus increasing investment risk and lowering investment returns (Abel and Eberly, 1996). With regard to financing decisions, intangible assets provide poor collateral value for debt financing, thus making them more suited to equity financing (Titman and Wessels, 1988). The continued growth of investments in intangibles, therefore, promises to significantly reshape the corporate landscape.

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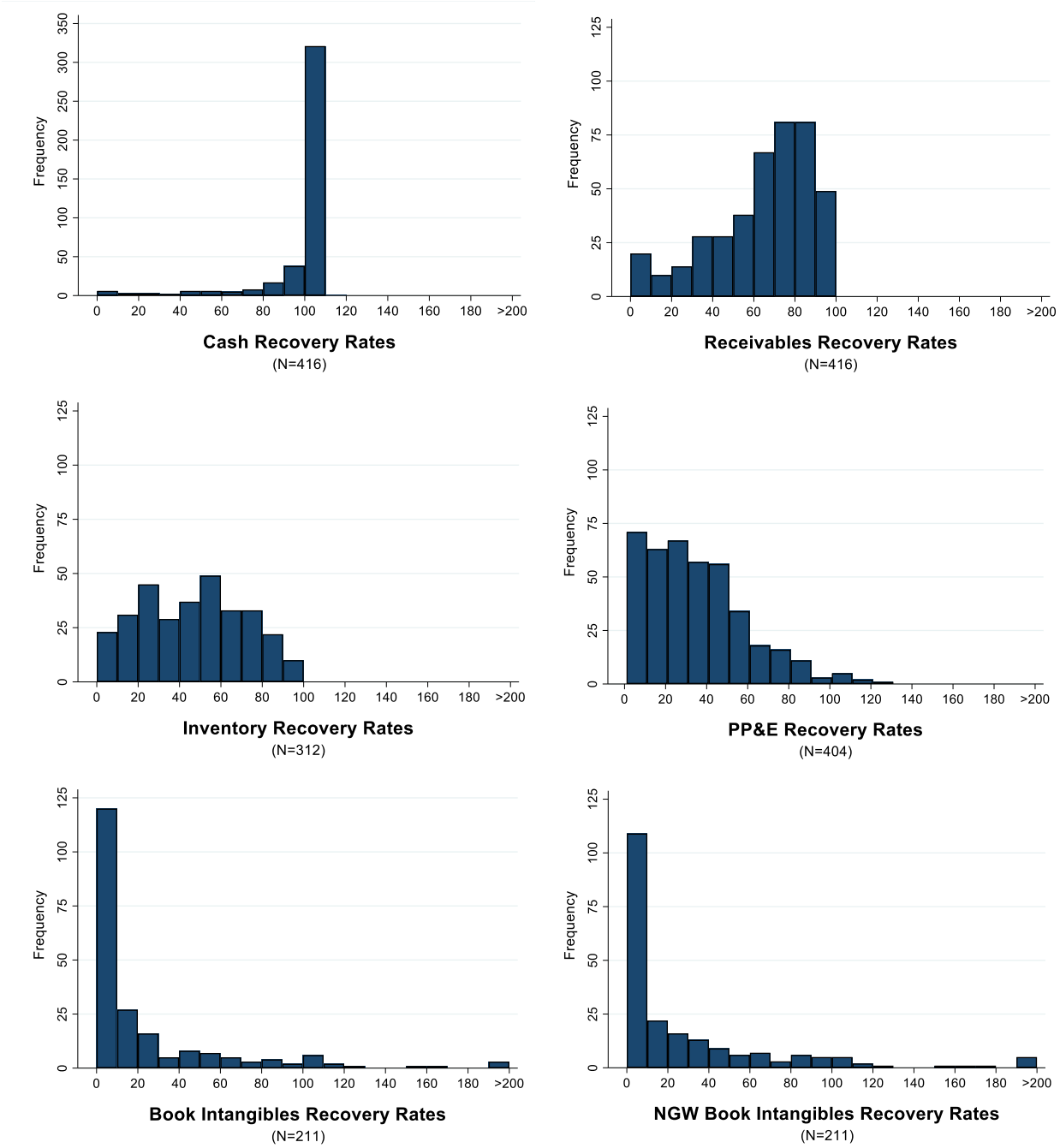
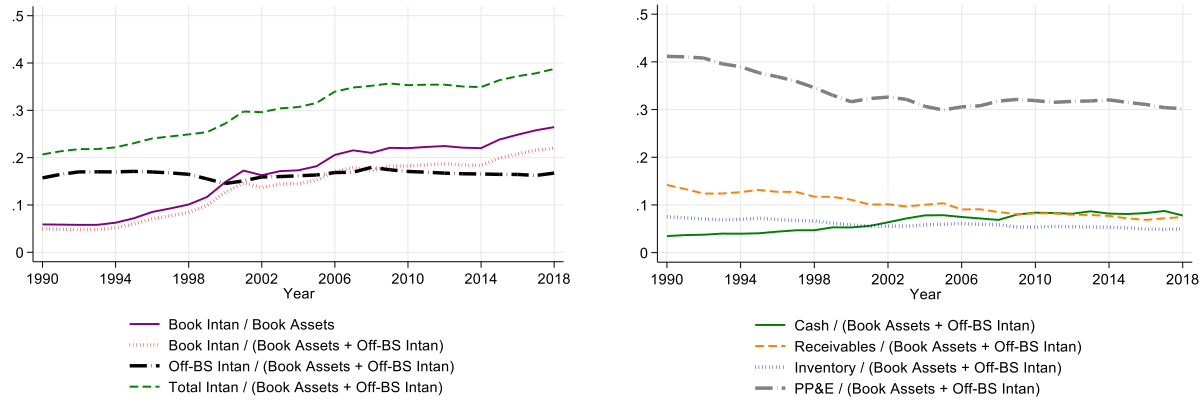
**Figure 1: The Distribution of K&M Firm-Level Recovery Rates by Asset Type**



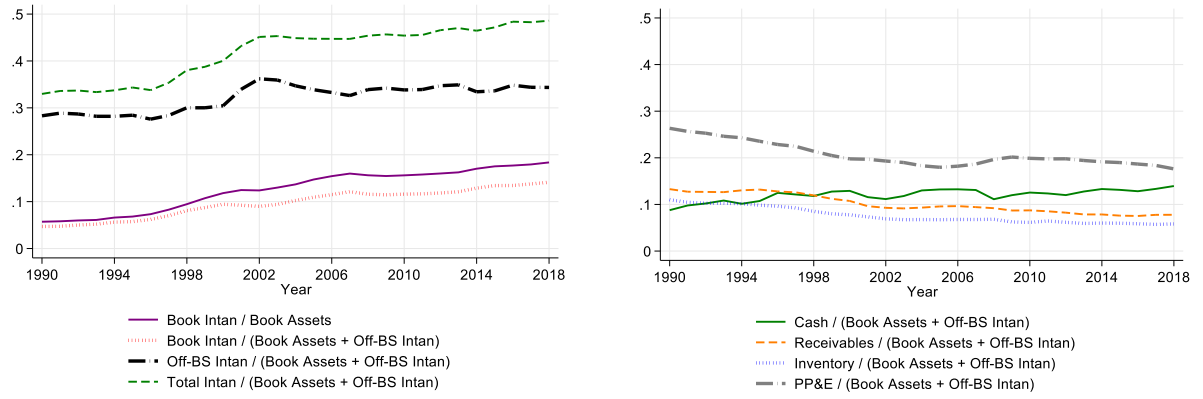

This figure presents the distribution of the original bankruptcy-firm-level recovery rates for the various asset types using data from Kermani and Ma (2023)'s 477 bankruptcy firms for which they obtained liquidation analyses.

## Figure 2: Asset Categories as a Percent of Total Assets Over Time

### *Panel A: Asset-weighted*



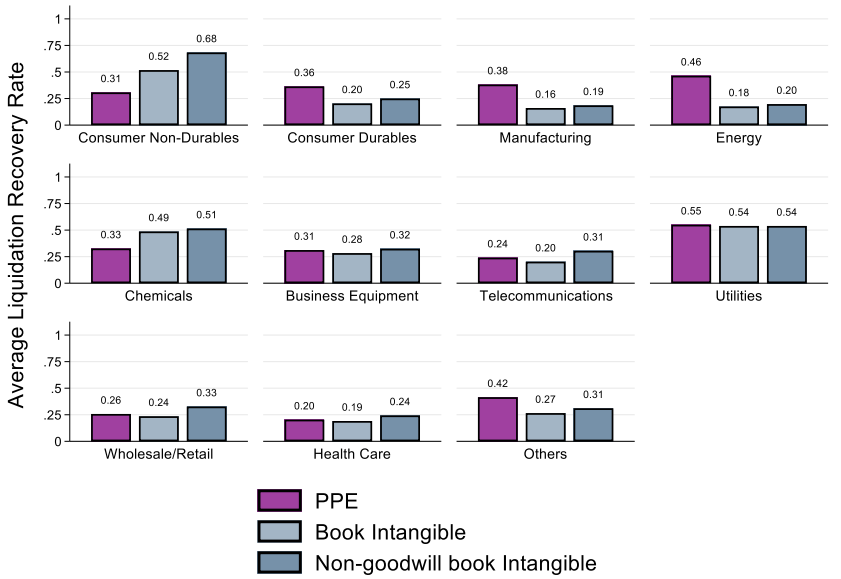

### *Panel B: Equal-weighted*



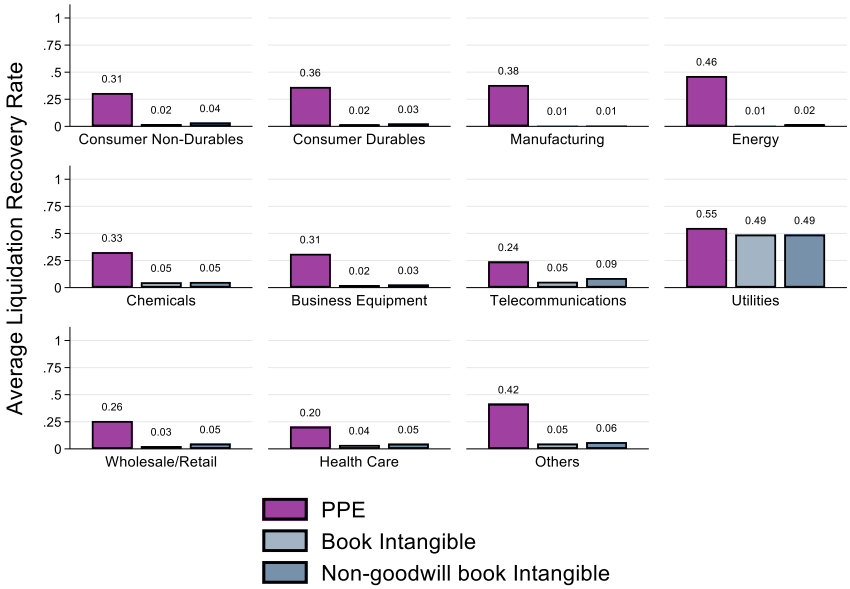

This figure presents the average value of each asset type normalized by total assets (as defined in figure legends) for Compustat firms from 1990 to 2018, excluding financial, public administration, and agricultural firms as well as those with non-classifiable SIC codes following Kermani and Ma (2023). Graphs also include only firm-years with non-missing total assets from Compustat and non-missing off-balance-sheet intangibles values per Peters and Taylor (2017). Panel A provides averages weighted by the measure of assets used in the denominator for each firm-year observation while Panel B shows results for equal-weighted averages. *Book Intan* represents book intangibles (including goodwill) from Compustat, with missing values set equal to zero. *Off-BS Intan* is the estimate of total off-balance-sheet intangible assets derived by Peters and Taylor (2017) and made available via WRDS. *Total Intan* is the sum of *Book Intan* and *Off-BS Intan*. *Book Assets* is total assets from Compustat. Amounts for other asset categories are obtained from Compustat. Variables are further defined in Appendix 2.

## Figure 3: Industry Average Liquidation Recovery Rates for PP&E and Intangibles

### *Panel A: Kermani and Ma (2023)*



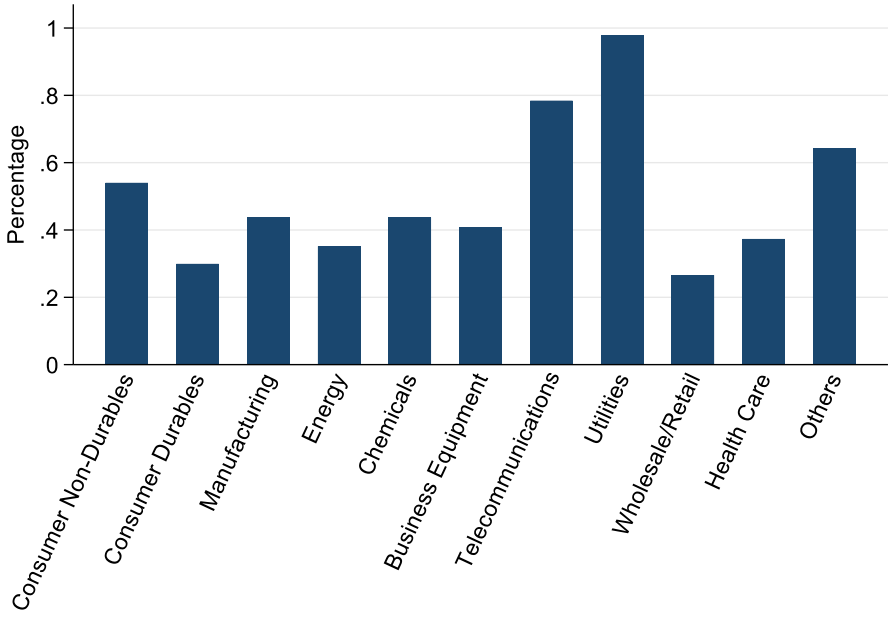

### *Panel B: After Our Adjustments*



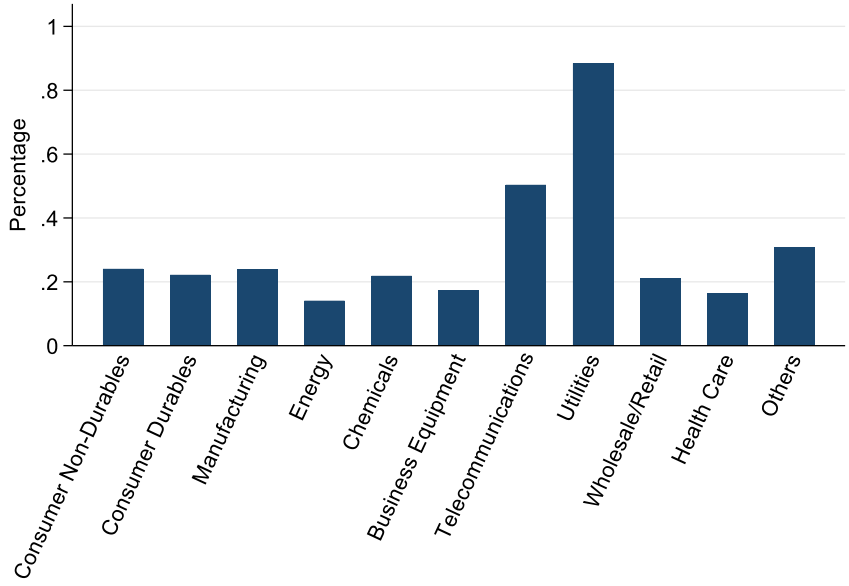

This figure examines recovery rates for PP&E and intangibles by Fama-French 12 industry classifications. Panel A presents Kermani and Ma (2023)'s original results using their 439 bankruptcy filings with liquidation analyses and at least one non-cash recovery rate, while Panel B shows results incorporating our adjustments using our final sample of 327 bankruptcy filings.

**Figure 4: Average Book Intangibles to Total Intangibles by Industry**

***Panel A: Asset-Weighted***



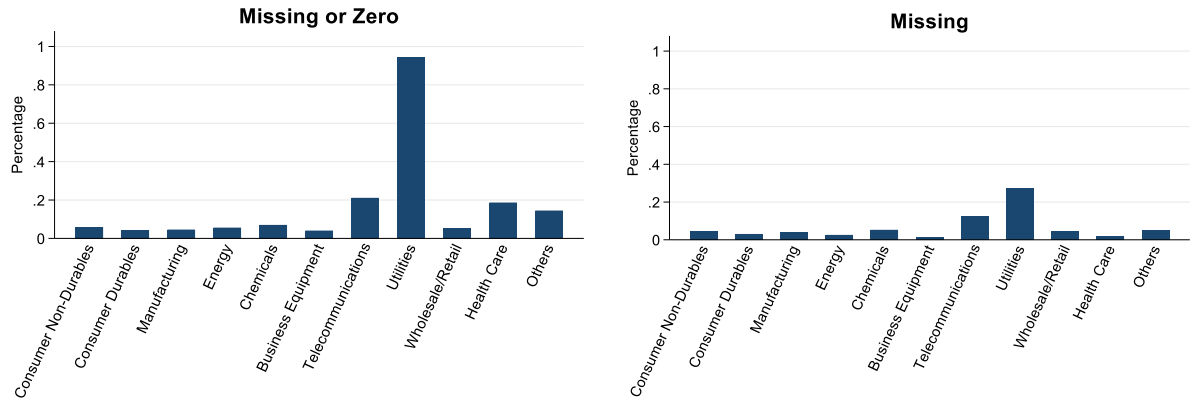

***Panel B: Equal-Weighted***



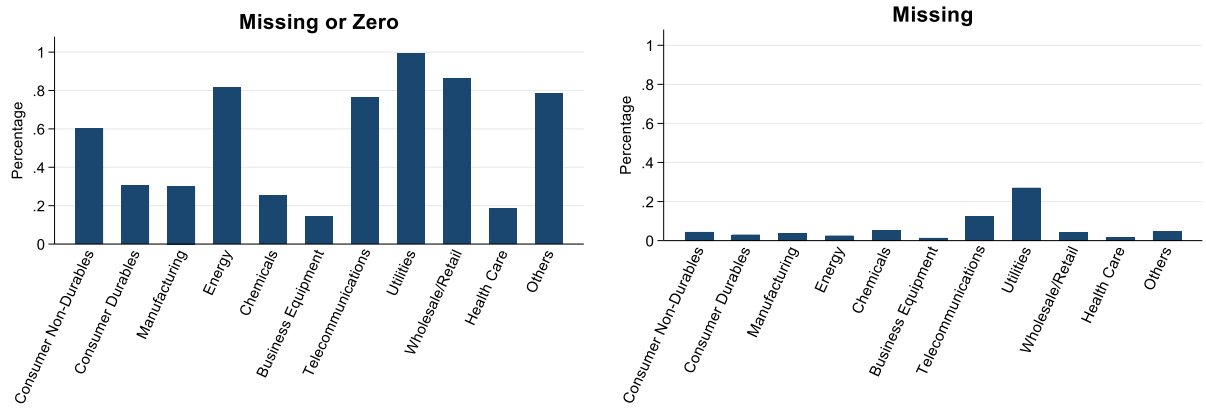

This figure presents the ratio of book intangibles (*Book Intan)* to total intangibles (*Book Intan* plus *Off-BS Intan*) by Fama-French 12 industry groups for Compustat firms from 1990 to 2018, excluding financial, public administration, and agricultural firms as well as those with non-classifiable SIC codes following Kermani and Ma (2023). Graphs also include only firm-years with non-missing values for *Off-BS Intan* (missing values for *Book Intan* are set equal to zero). Panel A provides averages weighted by the measure of total intangibles used in the denominator for each firm-year observation while Panel B provides equal-weighted averages. Variables are further defined in Appendix 2.

## Figure 5: Percentage of Firms with Missing or Zero Off-Balance-Sheet Intangibles by Industry

### *Panel A: Percentage of Firms with Missing or Zero Organization (SG&A) Off-Balance-Sheet Intangibles*



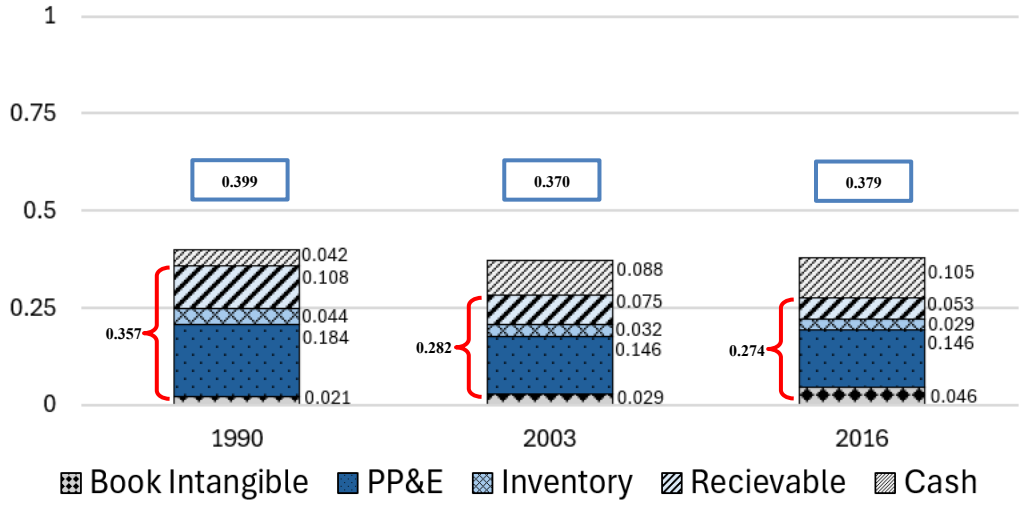

### *Panel B: Percentage of Firms with Missing or Zero Knowledge (R&D) Off-Balance-Sheet Intangibles*



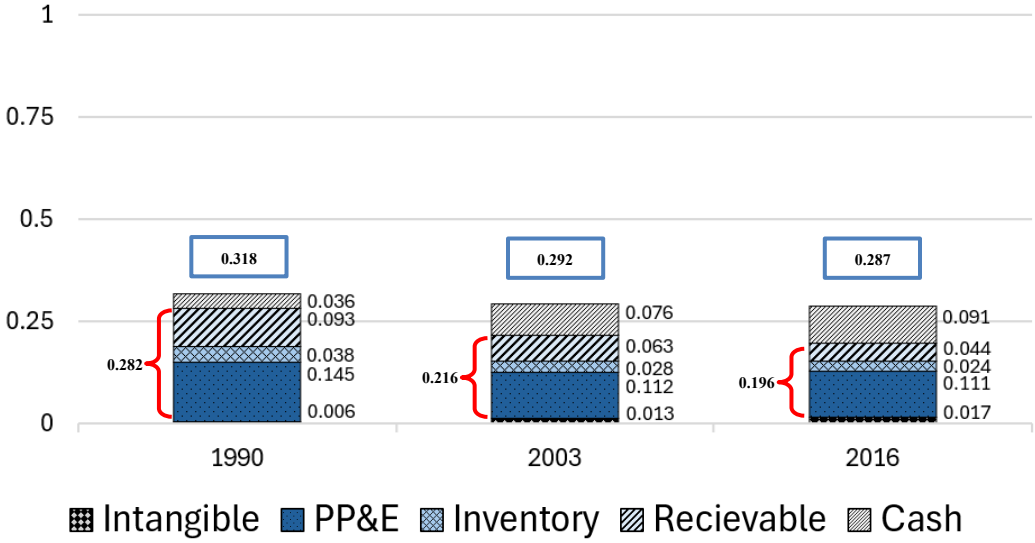

This figure presents the ratio of Compustat observations from 1990-2018, excluding financial, public administration, and agricultural firms as well as those with non-classifiable SIC codes following Kermani and Ma (2023), that have either zero or missing values for Peters and Taylor (2017) off-balance-sheet organization capital (i.e., previous SG&A expenses) or off-balance-sheet knowledge capital (i.e., previous R&D expenses) by Fama-French 12 industry groups. We include only firm-years with non-missing total sales as provided by Compustat. The first figure in each panel presents the combined results when the respective off-balance-sheet intangible is zero or missing for a given firm-year observation. The second figure in each panel presents results when the respective off-balance-sheet intangible is missing in the Peters and Taylor (2017) database for that firm-year observation.

**Figure 6: Liquidation Values Over Time**

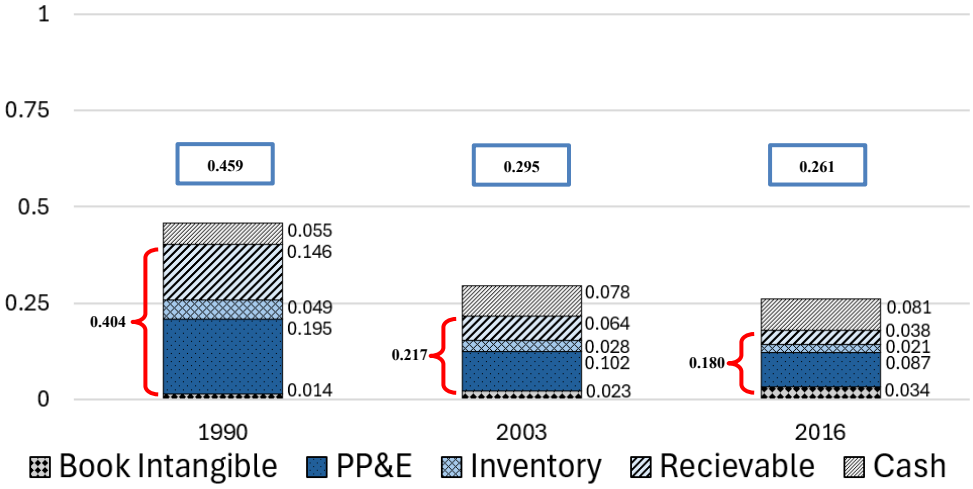
***Panel A: Kermani and Ma (2023) Original Liquidation Values Deflated by Total Book Assets***



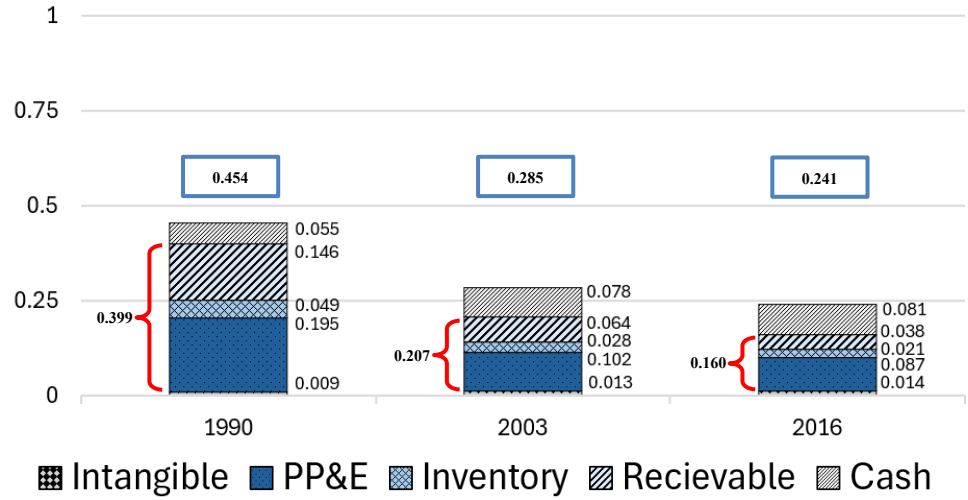

***Panel B: Our Revised Liquidation Values Deflated by the Sum of Total Book Assets and Off-Balance-Sheet Assets***



***Panel C: Kermani and Ma (2023) Original Liquidation Values Deflated by Enterprise Value***




***Panel D: Our Revised Liquidation Values Deflated by Enterprise Value***

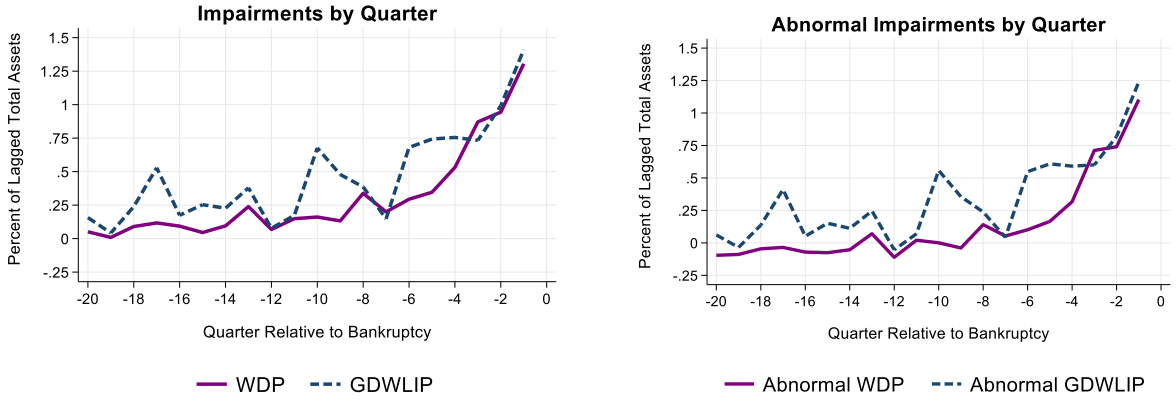



This figure presents the estimated total liquidation value for each asset type (intangibles, PP&E, inventory, receivables, and cash) among all Compustat firms (excluding financial, public administration, and agricultural firms as well as those with non-classifiable SIC codes) for 1990, 2003, and 2016. Additionally, following Kermani and Ma (2023), firm-years are only included if the firm has non-missing values for net PP&E, inventory, and receivables in that year and if the firm's industry has a non-missing average recovery rate available for each of these three asset categories. Panel A presents Kermani and Ma's (2023) original results scaled by Compustat total assets (using only firms that have non-missing Compustat total assets). For each firm, we multiply the book value of their asset categories by its respective industry-level recovery rate. We follow K&M in calculating intangible liquidation values as book intangibles minus goodwill multiplied by the nongoodwill intangibles recovery rate for that industry. If goodwill is missing, we instead multiply total book intangibles by the combined intangibles recovery rate for that industry. If total intangibles are missing, a liquidation value of zero is assumed. Panel B presents results using our adjusted recovery rates and including Peters and Taylor (2017) off-balance-sheet intangibles in both the intangibles values for estimating recoveries and in the denominator (using firms that have both non-missing Compustat total assets and non-missing P&T intangibles). Additionally, because we cannot distinguish between goodwill and nongoodwill off-balance-sheet intangible assets, we only analyze combined intangibles with the combined intangibles recovery rates. Specifically, we add P&T off-balance-sheet intangibles to Compustat book intangibles, filling book intangibles with zero when it is missing but there is a positive P&T value. We then multiply this value by the combined intangibles recovery rate. Aggregated liquidation values in these two panels are weighted by the measure of assets used in the denominator.

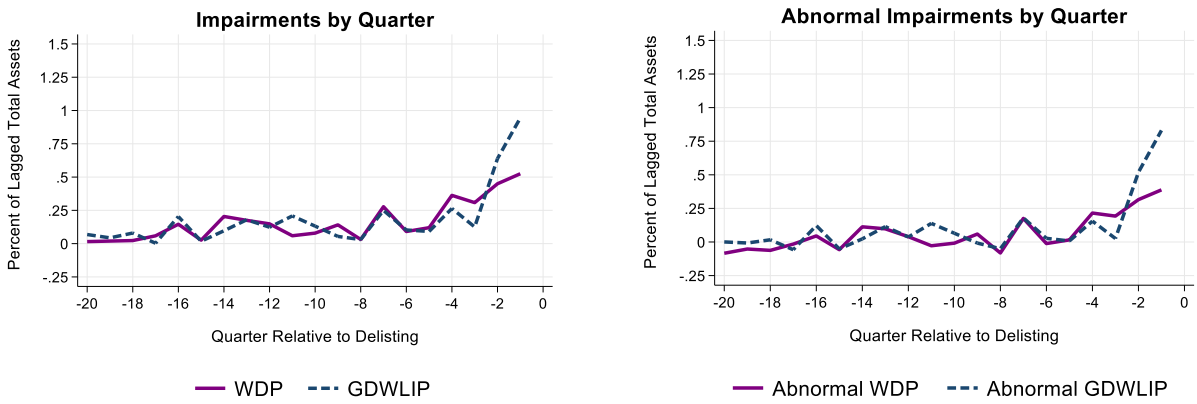
Panel C presents a revised version of Panel A scaling by the firm's total enterprise value (using only firms that have non-missing enterprise value). Panel D presents a revised version of Panel B scaling by the firm's total enterprise value (using only firms that have non-missing enterprise value). Aggregated liquidation values in these two panels are weighted by enterprise value. One observation generates a negative enterprise value due to the misclassification of notes receivable as negative notes payable. Using information from the firm's annual report, we correct the debt value to omit the notes receivable.

## Figure 7: Average Impairments Leading Up to Bankruptcy

***Panel A: Impairments and Write-downs Prior to Bankruptcies in the K&M Sample***




***Panel B: Impairments and Write-downs Prior to Bankruptcy-Related Delisting on CRSP***




This figure presents the average percentage of lagged total assets that are impaired or written off in the fiscal quarters leading up to bankruptcy and delisting. Panel A presents results for Kermani and Ma (2023)'s sample of bankruptcy firms for which we can link to Compustat, where the x-axis is fiscal quarters prior to bankrtupcy and the y-axis is the impairment as a percentage of lagged total assets. *WDP* represents pre-tax writedowns in that quarter (excluding goodwill and unamortized intangibles) scaled by lagged total assets. *GDWLIP* represents pre-tax writedowns of goodwill, impairments of goodwill and other intangibles when combined, and impairments of unamortized intangibles all scaled by lagged total assets. Abnormal *WDP* and abnormal *GDWLIP* are calculated as the percentage of lagged total assets impaired for the bankrtupcy firm in that fiscal quarter (either *WDP* or *GDWLIP*) minus the average percentage of lagged total assets impaired for all firms on Compustat in that fiscal quarter. Bankruptcy filings with no Compustat quarterly data in the calendar year leading up to the bankruptcy filing date are excluded from analysis. In some cases, there are also a series of missing data on Compustat in the middle of the run-up period to bankrtupcy. In these cases, we drop all quarterly observations that appear before (but not after) the data series gap. Panel B presents similar results for a sample of CRSP firms with bankruptcy-related delsitings between 1990 and 2018 (using delisting code 574). We require CRSP observations to be linked to Compustat for analysis. All other variables are defined and calculated as in Panel A.

**Table 1: Descriptive Statistics for Firm-Level Liquidation Recovery Rate in K&M Sample**

| | N | Mean | Std | Min | P25 | P50 | P75 | Max |
|---|---|---|---|---|---|---|---|---|
| Cash | 416 | 93.92 | 18.37 | 0.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Receivables | 416 | 64.07 | 24.44 | 0.00 | 50.00 | 70.00 | 82.88 | 100.00 |
| Inventory | 312 | 45.92 | 25.20 | 0.00 | 25.00 | 46.31 | 65.88 | 100.00 |
| PP&E | 404 | 35.34 | 24.77 | 0.98 | 14.80 | 31.07 | 49.90 | 122.65 |
| Book Intangibles | 211 | 26.89 | 69.78 | 0.00 | 0.00 | 4.98 | 25.70 | 799.00 |
| NGW Book Intangibles | 212 | 33.37 | 74.56 | 0.00 | 0.00 | 8.85 | 34.21 | 799.00 |

This table presents firm-level descriptive statistics for Kermani and Ma's (2023) original recovery rates for the 477 bankruptcy firms for which they obtained liquidation analyses.

## Table 2: Reliability of K&M Industry-Level Recovery Rates

***Panel A: Proportion of Industries with Greater than N Observations***

| | Cash | Receivables | Inventory | PP&E | Book Intangibles | NGW Book Intangibles |
|---|---|---|---|---|---|---|
| N > 1 | 0.92 | 0.87 | 0.81 | 0.92 | 0.74 | 0.74 |
| N > 3 | 0.65 | 0.66 | 0.60 | 0.65 | 0.49 | 0.49 |
| N > 5 | 0.48 | 0.49 | 0.44 | 0.50 | 0.33 | 0.33 |

***Panel B: Relation Between Firm and Industry-Level Recovery Rates***

| | ***PP&E Firm Rate*** | | | ***NGW Firm Rate*** | | |
|---|---|---|---|---|---|---|
| | N > 1 | N > 3 | N > 5 | N > 1 | N > 3 | N > 5 |
| *PP&E Ind Rate* | 0.354*** | 0.625*** | 0.697*** | | | |
| | (0.000) | (0.000) | (0.000) | | | |
| *NGW Ind Rate* | | | | -0.034 | 0.013 | -0.208 |
| | | | | (0.802) | (0.940) | (0.331) |
| Constant | 22.850*** | 13.207*** | 10.818** | 35.480*** | 34.423*** | 36.116*** |
| | (0.000) | (0.001) | (0.010) | (0.000) | (0.000) | (0.000) |
| Observations | 400 | 371 | 339 | 201 | 175 | 145 |
| R-Squared | 0.033 | 0.082 | 0.103 | 0.000 | 0.000 | 0.007 |

This table presents statistics assessing the reliability of K&M's industry-level recovery rates for intangibles. Panel A presents the proportion of industries (using two-digit SIC codes) with more than 1, 3, and 5 available recovery rate observations, respectively, from K&M's original recovery rate database. For each category, firms are only counted if they have a non-missing midpoint recovery rate for that respective asset category. Panel B regresses firm-level recovery rates for PP&E and nongoodwill intangibles on their respective industry-level recovery rates obtained using all other firms in the same two-digit SIC industry following K&M:

$\lambda_{ijk} = \alpha + \beta \bar{\lambda}_{(-i)jk} + \varepsilon_{ijk}$

where $\lambda_{ijk}$ is the firm-level liquidation recovery rate for firm $i$ in industry $j$ and asset type $k$, and $\bar{\lambda}_{(-i)jk}$ is the industry-level recovery rate for industry $j$ and asset type $k$ using all other firms in industry $j$ except for firm $i$. This is estimated using only industries with greater than one, three, or five firms, respectively. P-values are presented under regression coefficients where ***, **, and * represent significance at the p<0.01, p<0.05, and p<0.10 levels, respectively. Variables are further defined in Appendix 2.

## Table 3: Sample Construction

***Panel A: Bankruptcy Filing Sample Construction***

| **Sample** | **All Filings** |
|---|---|
| (1) All Bankruptcy Filings in Kermani & Ma (2023) (K&M) | 519 |
| (2) After dropping if K&M is missing liquidation document date | 477 |
| (3) After dropping if K&M is missing non-cash recovery rates | 439 |
| (4) After adding if we found recovery rates K&M is missing | 444 |
| (5) After dropping if cannot link to COMPUSTAT | 391 |
| (6) After dropping if not cannot link to Peters & Taylor (2017) | 327 |
| **Final Sample** | **327** |

***Panel B: Summary of Reasons for Differences in Recovery Rates***

| | |
|---|---|
| Our Final Sample of Bankruptcy Filings | 327 |
| **Differences** | |
| (1) Intangible with no book value but with recovery and with Peters and Taylor (2017) off-balance-sheet value | 22 |
| (2) No intangibles in liquidation analysis but have Peters and Taylor (2017) off-balance-sheet values (filled with zero recovery rate) | 161 |
| (3) Found different intangibles recovery rate than K&M in liquidation analysis | 11 |
| (4) Had same recovery rates before Peters and Taylor (2017) adjustment | 133 |
| **Total Differences** | **327** |

This table presents the details for the bankruptcy sample used to estimate industry-level recovery rates. In Panel A, we begin with all bankruptcies in the original Kermani and Ma (2023) (K&M) detailed recovery rates dataset. We then drop all bankruptcy filings where K&M was unable to locate liquidation analyses in the bankruptcy disclosure statements (measured using a missing liquidation analysis document date in their original dataset). We also drop observations where K&M found a liquidation analysis but did not pull any recovery rates besides cash. We then add back observations where we found liquidation recovery rates when K&M did not and drop if we cannot match the firm CIK to a Compustat GVKEY. We further drop observations if there is no Peter's and Taylor (2017) off-balance-sheet intangibles available for the company in the four years prior to the bankruptcy filing. In Panel B, we present a summary of the differences between our recovery rates and Kermani and Ma's (2023) recovery rates. Bankruptcy filings that have Peters and Taylor (2017) off-balance-sheet intangibles values but do not have any recovery rates in the liquidation analysis are assigned recovery rates of zero as it is assumed that if these off-balance-sheet intangibles had recoveries, they would be listed in the liquidation analysis. Three observations have multiple differences—each with no book value for intangibles and either a different recovery rate or intangibles value than K&M. These observations are included only once in the no-book-value category.

## Table 4: Intangible Liquidation Recovery Rate Samples & Statistics

***Panel A: Mean industry-level intangible recovery rates before and after adjustments***

| | | Mean | | Median | |
|---|---|---|---|---|---|
| | N | Intangibles | Nongoodwill Intangibles | Intangibles | Nongoodwill Intangibles |
| K&M Original | 211 | 24.83% | 32.03% | 17.58% | 22.94% |
| + our adjustments | 211 | 36.59% | 51.83% | 16.93% | 22.46% |
| + link to COMPUSTAT | 184 | 36.00% | 52.22% | 16.05% | 18.35% |
| + have available P&T | 148 | 38.13% | 44.97% | 11.06% | 17.59% |
| + P&T Off-BS | 327 | 2.85% | 3.79% | 0.90% | 1.13% |
| K&M Original with Our Sample | 147 | 22.68% | 26.29% | 12.12% | 18.35% |

***Panel B: Variability in industry-level intangible recovery rates before and after adjustments***

| | Min. & Max. | | Standard Deviation | |
|---|---|---|---|---|
| | Intangibles | Nongoodwill Intangibles | Intangibles | Nongoodwill Intangibles |
| K&M Original | [0.00, 139.76] | [0.00, 165.89] | 32.58 | 39.63 |
| + our adjustments | [0.00, 318.32] | [0.00, 352.61] | 61.08 | 82.75 |
| + link to COMPUSTAT | [0.00, 318.32] | [0.00, 352.61] | 62.22 | 84.48 |
| + have available P&T | [0.00, 461.51] | [0.00, 503.67] | 82.08 | 89.38 |
| + P&T Off-BS | [0.00, 36.70] | [0.00, 36.70] | 6.41 | 7.24 |
| K&M Original with Our Sample | [0.00, 136.26] | [0.00, 151.56] | 29.09 | 30.79 |

This table presents industry-level summary statistics for intangibles recovery rates from the liquidation analyses. Panel A shows the changes to Kermani and Ma (2023)'s original intangibles and nongoodwill intangibles recovery rates for each incremental step in our sample construction. N represents the number of non-missing intangibles recovery values used to calculate the recovery rates. We first make adjustments to the recovery rates when we computed a recovery rate that did not match Kermani and Ma (2023)'s original rates. We then require linking to Compustat and further require non-missing Peters and Taylor (2017) off-balance-sheet intangibles in one of the four years prior to the bankruptcy filing. Finally, we adjust for Peters and Taylor (2017) off-balance-sheet intangibles by dividing total intangibles recoveries by the sum of on- and off-balance-sheet intangibles and filling with zero when there is no recovery rate in the liquidation analysis but the firm has a positive value for Peters and Taylor (2017) off-balance-sheet intangibles. We also present rates using Kermani and Ma (2023)'s original recovery rates for our final sample of 327 bankruptcy firms. The rows for 'our adjustments', 'link to Compustat', and 'have available P&T' omit one bankruptcy that had an intangible recovery rate of 5,000,000%. If we include that recovery rate in those rows, the average intangible recovery rates increase to roughly 16,000%. It has little effect on the 'P&T Off-BS' adjustment row, as the dollar value recovery is further scaled by off-balance-sheet intangibles and becomes negligible. Panel B presents the minimum and maximum industry average recovery rates and the standard deviation of the recovery rates for each step in the sample construction.

**Table 5: Average Liquidation Recovery Rates by Industry and Intangible Asset Type**

| SIC2 | Intangible (K&M) | Nongoodwill Intangible (K&M) | Intangible (Adjusted) | Nongoodwill Intangible (Adjusted) |
|---|---|---|---|---|
| 10 Metal mining | 0.18 | 0.18 | 0.07 | 0.07 |
| 12 Coal mining | 0.24 | 0.24 | 0.03 | 0.03 |
| 13 Oil/gas extraction | 0.15 | 0.18 | 0.01 | 0.02 |
| 14 Quarrying-nonmetals | 0.00 | 0.00 | - | - |
| 15 Building construction | 0.00 | 0.00 | 0.00 | 0.00 |
| 16 Other heavy construction | - | - | - | - |
| 17 Construction contractors | - | - | 0.00 | 0.00 |
| 20 Food products | **1.40*** ** | **1.40*** ** | 0.01 | 0.01 |
| 22 Textile products | 0.25 | **1.66** ** | 0.00 | 0.00 |
| 23 Apparel products | **1.09** | **1.09** | 0.01 | 0.01 |
| 24 Wood products | 0.02 | 0.02 | 0.00 | 0.00 |
| 25 Furniture and fixtures | 0.13 | 0.27 | 0.00 | 0.00 |
| 26 Paper products | 0.06 | 0.12 | 0.00 | 0.00 |
| 27 Printing and publishing | 0.14 | 0.22 | 0.04 | 0.07 |
| 28 Chemical products | 0.46 | 0.48 | 0.05 | 0.05 |
| 30 Rubber and plastics products | 0.11 | 0.13 | 0.00 | 0.00 |
| 32 Stone, clay, glass, and concrete | 0.23 | 0.23 | 0.00 | 0.00 |
| 33 Primary metal | 0.25 | 0.25 | 0.02 | 0.02 |
| 34 Fabricated metal | 0.24 | 0.27 | 0.01 | 0.03 |
| 35 Machinery | 0.00 | 0.00 | 0.01 | 0.01 |
| 36 Electronic equipment | 0.38 | 0.45 | 0.02 | 0.02 |
| 37 Transportation equipment | 0.21 | 0.21 | 0.01 | 0.01 |
| 38 Analytical instruments | 0.32 | 0.32 | 0.03 | 0.03 |
| 39 Misc. manufacturing | 0.20 | 0.31 | 0.06 | 0.10 |
| 41 Local transit | 0.00 | 0.00 | 0.00 | 0.00 |
| 42 Motor freight | 0.02 | 0.05 | 0.00 | 0.00 |
| 44 Water transportation | - | - | 0.00 | 0.00 |
| 45 Transportation by air | **1.36*** ** | **1.52*** ** | 0.25*** | 0.31*** |
| 47 Transportation services | 0.00 | 0.00 | 0.00 | 0.00 |
| 48 Communications | 0.20 | 0.31 | 0.05 | 0.09 |
| 49 Electric and gas | 0.44 | 0.49 | 0.37*** | 0.37*** |
| 50 Wholesale durables | 0.06 | 0.07 | 0.01 | 0.01 |
| 51 Wholesale non-durables | 0.31 | 0.48 | 0.07 | 0.13 |
| 52 Building materials dealers | 0.00 | 0.00 | 0.00 | 0.00 |
| 53 General merchandise stores | - | - | 0.00 | 0.00 |
| 54 Grocery stores | 0.13 | 0.23 | 0.02 | 0.03 |
| 55 Automotive dealers | 0.01 | 0.01 | - | - |
| 56 Apparel stores | 0.27 | 0.30 | 0.02 | 0.04 |
| 57 Furniture stores | - | - | 0.00 | 0.00 |
| 58 Restaurants | 0.22 | 0.42 | 0.03 | 0.04 |
| 59 Misc. retail | 0.60 | 0.60 | 0.03 | 0.06 |
| 70 Lodging | 0.37 | 0.42 | 0.02 | 0.02 |
| 72 Personal services | 0.00 | 0.01 | 0.00 | 0.01 |
| 73 Business services | 0.06 | 0.10 | 0.02 | 0.03 |
| 75 Automotive repair | - | - | - | - |
| 78 Motion pictures | 0.01 | 0.01 | 0.00 | 0.00 |
| 79 Amusement and recreation | 0.43 | 0.44 | 0.01 | 0.01 |
| 80 Health services | 0.04 | 0.13 | 0.01 | 0.04 |
| 82 Educational services | 0.08 | 0.17 | 0.04 | 0.09 |
| 87 Professional services | - | - | 0.00 | 0.00 |

This table presents the average liquidation recovery rates for each intangible asset category in each two-digit SIC code. The first two columns present K&M's rates, which are industry average recovery rates using their original data and sample of 439 bankruptcy filings with liquidation analyses and recoveries. The last two columns present our adjusted rates, which are industry average recovery rates using our final sample of 327 bankruptcy filings and incorporating our adjustments. Recovery rates exceeding 100% are bolded for emphasis. Stars in both panels are from two-sided t-tests comparing the respective average industry-level recovery rate to the sample-wide average recovery rate when excluding that industry, where ***, **, and * relate to two-sided significance at the $p<0.01$, $p<0.05$, and $p<0.10$ levels, respectively.

**Table 6: Bankruptcy Sample Intangible Liquidation Value Estimation Errors**

| | N | Mean | Std | Min | P25 | P50 | P75 | Max |
|---|---|---|---|---|---|---|---|---|
| **K&M: Industry Mean** | | | | | | | | |
| Error | 298 | -0.009 | 0.078 | -1.021 | -0.003 | 0.000 | 0.000 | 0.216 |
| Absolute Error | 298 | 0.023 | 0.074 | 0.000 | 0.000 | 0.000 | 0.017 | 1.021 |
| Squared Error | 298 | 0.006 | 0.062 | 0.000 | 0.000 | 0.000 | 0.000 | 1.043 |
| **Adjusted: Industry Mean** | | | | | | | | |
| Error | 298 | 0.001 | 0.047 | -0.290 | -0.011 | -0.002 | 0.000 | 0.302 |
| Absolute Error | 298 | 0.021 | 0.042 | 0.000 | 0.001 | 0.007 | 0.020 | 0.302 |
| Squared Error | 298 | 0.002 | 0.010 | 0.000 | 0.000 | 0.000 | 0.000 | 0.091 |
| **K&M: Sample-Wide Mean** | | | | | | | | |
| Error | 327 | -0.006 | 0.043 | -0.220 | -0.004 | 0.000 | 0.000 | 0.208 |
| Absolute Error | 327 | 0.019 | 0.039 | 0.000 | 0.000 | 0.000 | 0.017 | 0.220 |
| Squared Error | 327 | 0.002 | 0.006 | 0.000 | 0.000 | 0.000 | 0.000 | 0.048 |
| **Adjusted: Sample-Wide Mean** | | | | | | | | |
| Error | 327 | -0.000 | 0.040 | -0.039 | -0.017 | -0.006 | -0.001 | 0.304 |
| Absolute Error | 327 | 0.019 | 0.035 | 0.000 | 0.004 | 0.011 | 0.021 | 0.304 |
| Squared Error | 327 | 0.002 | 0.008 | 0.000 | 0.000 | 0.000 | 0.000 | 0.092 |

This table presents intangible liquidation value estimation errors using either K&M's original recovery rates (K&M) or our adjusted liquidation recovery rates (Adjusted). This is done for our final sample of 327 firms. For each firm, we compute the liquidation value estimation error as the difference between the actual intangible recovery value in the liquidation analysis and the estimated recovery value implied by either K&M's original or our adjusted recovery rates. Estimation errors are calculated in two different ways. First, we compare actual firm-level recoveries to the implied recoveries when using the *industry* average recovery rate (denoted by the "Industry Mean" label). A separate industry-average recovery rate is computed for each observation by excluding the observation itself from its industry average. This average rate is then applied to the firm's intangibles using either K&M's original method or our adjusted method of calculating liquidation values. Second, we compare firm-level recoveries to the implied recoveries when using the *sample*-wide mean recovery rate (denoted by the "Sample-Wide Mean" label). For each observation, we calculate a new sample-wide average recovery rate by excluding the observation itself from the sample-wide average. This rate is then applied to the firm's intangibles using either K&M's original method or our adjusted method of calculating liquidation values. To calculate K&M recoveries, we follow their original method and multiply nongoodwill intangibles by the nongoodwill intangible recovery rates, if available. If missing, we multiply combined

intangibles by the combined intangibles recovery rate. If nongoodwill intangibles and the combined intangibles value are both missing, then the estimated recovery is set to zero. To calculate our adjusted recoveries, we sum goodwill, nongoodwill book intangibles, and P&T off-balance-sheet intangibles (filling with zero when one or two are missing but the other(s) are not) and multiply by our adjusted combined intangibles recovery rate. If the liquidation analysis reports a combined value for goodwill and nongoodwill intangibles, then this combined value is added to P&T off-balance-sheet intangibles and subsequently multiplied by the combined intangibles recovery rate. Errors in both methods are scaled by the sum of total assets using K&M's "Total Book Value" variable and P&T off-balance-sheet intangibles, and we report descriptive statistics for the errors, the absolute errors, and squared errors. We find one instance where K&M missed pulling the "Total Book Value" from the liquidation analysis; we fill in this missing value using information from the liquidation analysis for that bankruptcy case. The industry results also require that each observation's industry includes more than one observation so that an industry-mean recovery rate can be computed after excluding that observation (this decreases the sample by 29 observations).

**Table 7: Summary Statistics for Intangible Asset Categories in the Compustat Sample**

***Panel A: Univariate Descriptive Statistics***

| | Mean | Std | Min | P25 | P50 | P75 | Max |
|---|---|---|---|---|---|---|---|
| *Book Intan* / (*Book Assets* + *Off-BS Intan*) | 0.10 | 0.15 | 0.00 | 0.00 | 0.02 | 0.13 | 1.00 |
| *NGW Book Intan* / (*Book Assets* + *Off-BS Intan*) | 0.05 | 0.09 | 0.00 | 0.00 | 0.01 | 0.05 | 1.00 |
| *Off-BS Intan* / (*Book Assets* + *Off-BS Intan*) | 0.32 | 0.24 | 0.00 | 0.13 | 0.29 | 0.46 | 1.00 |
| Ln(*Enterprise Value*) | 5.66 | 2.18 | -2.20 | 4.05 | 5.56 | 7.16 | 13.99 |
| *Book Intan Indicator* | 0.60 | 0.49 | 0.00 | 0.00 | 1.00 | 1.00 | 1.00 |
| *NGW Book Intan Indicator* | 0.32 | 0.47 | 0.00 | 0.00 | 0.00 | 1.00 | 1.00 |

***Panel B: Pairwise Correlations***

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| (1) *Book Intan* / (*Book Assets* + *Off-BS Intan*) | 1.00 | 0.84*** | -0.22*** | 0.33*** | 0.84*** | 0.53*** |
| (2) *NGW Book Intan* / (*Book Assets* + *Off-BS Intan*) | 0.74*** | 1.00 | -0.21*** | 0.28*** | 0.71*** | 0.85*** |
| (3) *Off-BS Intan* / (*Book Assets* + *Off-BS Intan*) | -0.28*** | -0.22*** | 1.00 | -0.36*** | -0.11*** | -0.00 |
| (4) Ln(*Enterprise Value*) | 0.29*** | 0.16*** | -0.36*** | 1.00 | 0.25*** | 0.32*** |
| (5) *Book Intan Indicator* | 0.47*** | 0.31*** | -0.15*** | 0.25*** | 1.00 | 0.56*** |
| (6) *NGW Book Intan Indicator* | 0.39*** | 0.38*** | -0.02*** | 0.32*** | 0.56*** | 1.00 |

This table presents summary statistics for Compustat firms from 1990 to 2018. We exclude financial, public administration, and agricultural firms as well as those with non-classifiable SIC codes, following Kermani and Ma (2023). Additionally, in line with Figure 6, firm-years are only included if the firm has non-missing values for net PP&E, inventory, and receivables in that year and if the firm's industry has a non-missing average recovery rate available for each of these three asset categories. Finally, we require non-missing Compustat total assets and non-missing P&T off-balance-sheet intangibles. Panel A reports descriptive statistics for several variables: (i) book intangibles scaled by the sum of on-balance-sheet assets and Peters and Taylor (2017) off-balance-sheet intangibles; (ii) nongoodwill book intangibles scaled by the sum of on-balance-sheet assets and Peters and Taylor (2017) off-balance-sheet intangibles; (iii) Peters and Taylor (2017) off-balance-sheet intangibles scaled by the same denominator; (iv) the natural log of enterprise value, defined as the log of the sum of market equity and total debt; (v) an indicator variable equal to one if the firm reports non-zero intangible assets on the balance sheet in that year, and zero otherwise (*Book Intan Indicator*); and (vi) an indicator variable equal to one if the firm reports non-zero nongoodwill intangible assets on the balance sheet in that year, and zero otherwise (*NGW Book Intan Indicator*). Panel B reports both Pearson (lower triangle) and Spearman (upper triangle) correlation coefficients between the variables in Panel A. Statistical significance is denoted by ***, **, and * for two-tailed p-values less than 0.01, 0.05, and 0.10, respectively. Variables are further defined in Appendix 2.

## Table 8: Regressions of Firm Characteristics on Overall Non-Cash Recovery Rates

***Panel A: Non-Cash Recovery Rates Excluding Intangibles***

| VARIABLES | (1) Leverage | (2) Cash | (3) Gross Margin | (4) Leverage | (5) Cash | (6) Gross Margin |
|---|---|---|---|---|---|---|
| ***K&M Non-Cash Recovery Rates*** | **0.099** | **-0.286*** ** | **-0.295*** | | | |
| | **(0.386)** | **(0.006)** | **(0.068)** | | | |
| ***Our Non-Cash Recovery Rates*** | | | | **0.422*** ** | **-0.230*** ** | **-0.544*** ** |
| | | | | **(0.002)** | **(0.000)** | **(0.007)** |
| Constant | 25.736*** | 22.418*** | 41.354*** | 12.658*** | 14.238*** | 44.291*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Omit Industries with P&T Classification Issues | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** |
| Observations | 38 | 38 | 38 | 38 | 38 | 38 |
| R-squared | 0.020 | 0.155 | 0.104 | 0.229 | 0.296 | 0.289 |

***Panel B: Non-Cash Recovery Rates Using Industry-Level Intangibles Recovery Rates***

| VARIABLES | (1) Leverage | (2) Cash | (3) Gross Margin | (4) Leverage | (5) Cash | (6) Gross Margin |
|---|---|---|---|---|---|---|
| ***K&M Non-Cash Recovery Rates*** | **0.081** | **-0.246*** ** | **-0.239** | | | |
| | **(0.450)** | **(0.006)** | **(0.113)** | | | |
| ***Our Non-Cash Recovery Rates*** | | | | **0.405*** ** | **-0.225*** ** | **-0.537*** ** |
| | | | | **(0.004)** | **(0.001)** | **(0.009)** |
| Constant | 26.175*** | 21.502*** | 39.876*** | 12.784*** | 14.291*** | 44.512*** |
| | (0.000) | (0.000) | (0.000) | (0.001) | (0.000) | (0.000) |
| Omit Industries with P&T Classification Issues | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** |
| Observations | 38 | 38 | 38 | 38 | 38 | 38 |
| R-squared | 0.014 | 0.125 | 0.073 | 0.196 | 0.266 | 0.263 |

***Panel C: Non-Cash Recovery Rates Using Sample-Wide Intangibles Recovery Rates***

| VARIABLES | (1) Leverage | (2) Cash | (3) Gross Margin | (4) Leverage | (5) Cash | (6) Gross Margin |
|---|---|---|---|---|---|---|
| ***K&M Non-Cash Recovery Rates*** | **0.099** | **-0.286*** ** | **-0.295*** | | | |
| | **(0.387)** | **(0.006)** | **(0.068)** | | | |
| ***Our Non-Cash Recovery Rates*** | | | | **0.422*** ** | **-0.230*** ** | **-0.544*** ** |
| | | | | **(0.002)** | **(0.000)** | **(0.007)** |
| Constant | 25.737*** | 22.421*** | 41.354*** | 12.655*** | 14.242*** | 44.299*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Omit Industries with P&T Classification Issues | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** |
| Observations | 38 | 38 | 38 | 38 | 38 | 38 |
| R-squared | 0.020 | 0.155 | 0.103 | 0.228 | 0.296 | 0.289 |

This table presents industry-level regression results analyzing the relation between industry-average firm characteristics and non-cash recovery rates, using Compustat firms from 1990 to 2018. We require firms to be in an industry where an industry-level intangible recovery rate was available for both K&M and Our Adjusted rates. Additionally, in line with Figure 6, firm-years are only included if the firm has non-missing values for net PP&E, inventory, and receivables in that year and if the firm's industry has a non-missing average recovery rate available for each of these three asset categories. Finally, we require non-missing Compustat total assets, non-missing P&T off-balance-sheet intangibles, and non-missing values for all dependent variables. Regressions exclude the 'Transportation by Air', 'Communications', and 'Electric and Gas' industries, as these industries have biased estimates of P&T off-balance-sheet intangibles due to Compustat classification rules. We also exclude financial, public administration, and agricultural firms as well as those with non-classifiable SIC codes, following Kermani and Ma (2023). In regressions using K&M rates, *Leverage* is calculated as the sum of short- and long-term debt scaled by Compustat total assets, multiplied by 100. In regressions using our rates, *Leverage* is calculated as the sum of short- and long-term debt scaled by the sum Compustat total assets and P&T off-balance-sheet intangibles, multiplied by 100. In regressions using K&M rates, *Cash* is calculated as cash and cash equivalents scaled by Compustat total assets, multiplied by 100. In regressions using our rates, *Cash* is calculated as cash and cash equivalents scaled by the sum of Compustat total assets and P&T off-balance-sheet intangibles, multiplied by 100. *Gross Margin* is calculated as sales minus cost of goods sold, scaled by sales and multiplied by 100. This calculation is the same for all regressions. All dependent variables are calculated at the firm-year level and then averaged at the industry level. When calculating non-cash recovery rates, we first calculate firm-level non-cash recovery rates for the observations in the sample described above and take the industry average (using two-digit SIC). Specifically, *K&M Non-Cash Recovery Rates* for industry I are calculated as follows:

$$\begin{aligned} \textit{K\&M Non-Cash Recovery Rate}_I = \sum(&\textit{RecoveryReceivableMid}_I * (\textit{Receivables / Non-Cash Book Assets}) + \\ &\textit{RecoveryInventoryMid}_I * (\textit{Inventory / Non-Cash Book Assets}) + \\ &\textit{RecoveryPPEMid}_I * (\textit{Net PP\&E / Non-Cash Book Assets}) + \\ &\textit{RecoveryIntanMid}_I * (\textit{Book Intangibles / Non-Cash Book Assets}))/N_I \end{aligned}$$

where $RecoveryReceivableMid_I$ is K&M's recovery rate for accounts receivable for industry I, *Receivables* is accounts receivable for firm j in year t, *Non-Cash Book Assets* is Compustat total assets minus cash and cash equivalents for firm j in year t, $RecoveryInventoryMid_I$ is K&M's recovery rate for inventory for industry I, *Inventory* is the inventory balance for firm j in year t, $RecoveryPPEMid_I$ is K&M's industry-level recovery rate for PP&E, *Net PP&E* is the net PP&E balance for firm j in year t, $RecoveryIntanMid_I$ is K&M's recovery rate for intangibles, *Book Intangibles* is the on-balance-sheet intangibles reported in Compustat, and $N_I$ is the count of firm-year observations in industry I used for the calculation of the non-cash recovery rate. For the intangibles portion of the calculation for K&M's rates, we follow K&M in calculating intangible liquidation values as book intangibles minus goodwill multiplied by the

nongoodwill intangibles recovery rate for that industry. If goodwill is missing, we instead multiply total book intangibles by the combined intangibles recovery rate for that industry. When calculating *Our Non-Cash Recovery Rates,* we replace K&M's intangible recovery rate with our adjusted rate and add P&T off-balance-sheet intangibles to the intangible value to which the recovery rate is applied. We also deflate each asset category by the sum of *Non-Cash Book Assets* and P&T off-balance-sheet intangibles (rather than just *Non-Cash Book Assets*). Each of the panels makes a different assumption about intangible recoveries. Panel A omits intangible recoveries altogether (i.e., assumes they are zero). Note that the results using *Our Non-Cash Recovery Rates* continue to incorporate P&T off-balance-sheet intangibles in the deflator when estimating recoveries for the other asset classes. Panel B uses industry-level non-cash recovery rates, while Panel C uses the sample-wide average intangibles recovery rate. P-values are presented under regression coefficients where ***, **, and * represent significance at the $p<0.01$, $p<0.05$, and $p<0.10$ levels, respectively. Variables are further defined in Appendix 2.

**Table 9: Regressions of Intangible Recovery Values on Intangible Asset Category Values**

| Dependent Variable = | ***Intangible Recovery*** | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | K&M Values | K&M Values | Adjusted Values | Adjusted Values |
| *Book Intan* | 0.056*** | | 0.059*** | |
| | (0.000) | | (0.000) | |
| *NGW Book Intan* | | 0.134*** | | 0.135*** |
| | | (0.000) | | (0.000) |
| *Book GW* | | -0.011 | | -0.007 |
| | | (0.584) | | (0.675) |
| *Off-BS Intan* | 0.032** | 0.032** | 0.021*** | |
| | (0.024) | (0.016) | (0.000) | |
| *Off-BS Know* | | | | 0.034*** |
| | | | | (0.000) |
| *Off-BS Org* | | | | 0.014** |
| | | | | (0.041) |
| Constant | -0.001 | -0.003 | -0.002 | -0.001 |
| | (0.890) | (0.628) | (0.560) | (0.639) |
| Omit Industries with P&T Classification Issues | Yes | Yes | Yes | Yes |
| Observations | 126 | 126 | 291 | 291 |
| R-squared | 0.122 | 0.245 | 0.131 | 0.211 |

This table presents regression results analyzing the relation between the value of recoveries for intangible assets from bankruptcy liquidation analyses and the on- and off-balance-sheet values for intangible assets, using only observations included in our final 327 bankruptcy firm sample. *Intangible Recovery* represents the dollar value of the estimated mid-point recovery for intangible assets found in the bankruptcy liquidation analyses for each firm. *Book Intan* represents the value of on-balance-sheet intangibles from the liquidation analysis. *NGW Book Intan* represents the nongoodwill value of on-balance-sheet intangibles from the liquidation analysis. *Book GW* is the book value of goodwill from the liquidation analysis. For liquidation analyses where combined goodwill and nongoodwill intangibles are reported, the combined amount is split into goodwill and nongoodwill portions using K&M's industry-specific goodwill-to-intangibles ratios. *Off-BS Intan* represents the value of off-balance-sheet intangible capital estimated using the procedure in Peters and Taylor (2017). *Off-BS Know* represents the value of off-balance-sheet intangible capital from R&D estimated using the procedure in Peters and Taylor (2017). *Off-BS Org* represents the value of off-balance-sheet intangible capital from SG&A estimated using the procedure in Peters and Taylor (2017). All variables are scaled by the sum of the book value of assets in the liquidation analysis (per K&M's original dataset) and P&T off-balance-sheet intangibles. In Columns (1) and (2), recoveries and book values use the data from K&M's original dataset. These columns require that the observation had an intangible recovery rate pulled by K&M that was used in K&M's calculation of their industry average rates. In Columns (3) and (4), recoveries and book values are adjusted for instances where we collect recoveries or book values that differ from those in K&M's dataset. These columns require that the observation had an intangible recovery rate that was used to calculate our industry average

rates. Additionally, since all regressions include *Off-BS Intan* as a regressor, they exclude observations in the 'Transportation by Air', 'Communications', and 'Electric and Gas' industries, as these industries have biased estimates of P&T off-balance-sheet intangibles due to Compustat classification rules (this excludes 36 observations). P-values are presented under regression coefficients where ***, **, and * represent significance at the $p<0.01$, $p<0.05$, and $p<0.10$ levels, respectively. Variables are further defined in Appendix 2.

## Appendix 1: Sample Liquidation Analyses

### Panel A: Liquidation Analysis for AMR Corporation



**American Airlines Debtors**
**Liquidation Analysis**
*(in US dollars, 000s)*

| Notes | | Net Book Value December 31, 2012 | Forced Liquidation Value: Estimated Value | Forced Liquidation Value: Estimated Realization Rate | Orderly Liquidation Value: Estimated Value | Orderly Liquidation Value: Estimated Realization Rate |
|---|---|---|---|---|---|---|
| | **ASSETS & ESTIMATED REALIZATION** | | | | | |
| 1 | Cash | $ 474,365 | $ 289,589 | 61% | $ 376,922 | 79% |
| 1 | Short-Term Investments | 4,257,192 | 4,157,158 | 98% | 4,206,429 | 99% |
| 2 | Receivables - Net | 1,103,986 | 706,973 | 64% | 717,700 | 65% |
| 3 | Inventories - Net | 549,950 | 401,146 | 73% | 561,897 | 102% |
| 4 | Other Current Assets | 624,597 | 235,370 | 38% | 244,432 | 39% |
| 5 | Operating Flight Equipment - Net | 10,185,420 | 3,982,261 | 39% | 5,419,741 | 53% |
| 6 | Leased Operating Flight Equipment - Net | 222,188 | - | 0% | - | 0% |
| 7 | Purchase Deposits - Flight Equipment | 710,106 | - | 0% | - | 0% |
| 8 | Other Equipment and Property - Net | 2,079,869 | 186,304 | 9% | 208,643 | 10% |
| 9 | Leased Other Equipment and Property - Net | 59,992 | - | 0% | - | 0% |
| 10 | Noncurrent Receivables - Net | 1,211,775 | 1,085,150 | 90% | 1,089,274 | 90% |
| 11 | Routes, Airport Slots & Gate Costs - Net | 868,962 | 3,198,719 | 368% | 3,655,679 | 421% |
| 12 | Investment in Subs | 494,585 | 1,116 | 0% | 1,116 | 0% |
| 13 | Other Assets | 913,646 | 70,435 | 8% | 104,896 | 11% |
| 14 | Intangible Assets | - | 170,750 | N/A | 289,000 | N/A |
| 15 | I/C Notes Receivable | 80,920 | 47,525 | 59% | 54,991 | 68% |
| | **Total Assets / Proceeds (A)** | **$ 23,837,553** | **$ 14,532,497** | **61%** | **$ 16,930,720** | **71%** |

11. Routes, Airport Slots & Gate Costs – Net: Routes, airport slots & gate costs – net includes the value of the routes, landing slot rights and gates owned by the Debtors. The balance sheet carrying values of these items reflect the actual cost, net of accumulated amortization, apportioned to these assets. The Liquidation Analyses base the value of foreign route authorities and arrival/departure slots at Ronald Reagan Washington National, John F. Kennedy, and LaGuardia airports on factors such as location, time (peak versus non-peak), existence of open skies agreements, level of slot congestion, and usage (jet versus commuter). The Liquidation Analyses rely on the Debtor's extensive industry knowledge and third party appraisals to determine a range of realization rates on account of slots and foreign route authorities.

14. Intangible Assets: Intangible Assets include customer databases, trade names, and trademarks. Given that the customer list was developed by AMR, there is no net book value on AMR's books and records as of December 31, 2012 for this asset. The analyses base their recovery assumptions for the Debtors' customer list on precedent analyses of similar assets in bankruptcy. The analyses also assume significant recoveries from the sale of the AA trade name based on the Debtors' recent appraisal of this asset and precedent transactions in other bankruptcies.

Authors' Note: This liquidation analysis is for the main operating subsidiary in the AMR Corporation consolidated group. The bankruptcy disclosure document presents liquidation analyses for several other subsidiaries, but they have no book values or recoveries for intangible assets.

**Panel B: Liquidation Analysis for Frontier Airlines Holdings, Inc**



**Consolidated Hypothetical Liquidation Analysis for Frontier Airlines Holdings, Inc. and its Subsidiaries (UNAUDITED)**

**ASSETS & ESTIMATED REALIZATION**
**(Hypothetical Liquidation Date Assumed to be April 30, 2009)**

| | Net Book Value as of 4/30/09 (in millions) (unless noted) | Forced Liquidation Value | | Orderly Liquidation Value | |
|---|---|---|---|---|---|
| | | *Estimated Value* | *Estimated Realized %* | *Estimated Value* | *Estimated Realized %* |
| 1 Cash and cash equivalents | $ 49.1 | $ 49.1 | 100.0% | $ 49.1 | 100.0% |
| 2 Restricted cash and investments | 166.4 | - | 0.0% | - | 0.0% |
| 3 Trade receivable, net | 37.6 | 2.8 | 7.5% | 5.6 | 15.0% |
| 4 Prepaid expenses and other current assets | 18.0 | - | 0.0% | 0.9 | 5.0% |
| 5 Fuel inventory and prepaid fuel | 9.3 | 7.4 | 80.0% | 8.4 | 90.0% |
| 6 Inventories, net | 7.6 | 1.8 | 24.0% | 1.8 | 24.0% |
| 7 Assets held for sale | 0.7 | 2.2 | 299.7% | 2.2 | 299.7% |
| 8 Security and other deposits | 30.8 | - | 0.0% | - | 0.0% |
| 9 Flight equipment and spare parts, net | 580.1 | 432.0 | 74.5% | 453.4 | 78.2% |
| 10 Ground support equipment and tooling | 7.9 | 19.7 | 249.2% | 19.7 | 249.2% |
| 11 Aircraft pre-delivery payments | 7.8 | - | 0.0% | - | 0.0% |
| 12 Deferred loan costs | 5.4 | - | 0.0% | - | 0.0% |
| 13 Deferred expenses and credits | 0.1 | - | 0.0% | - | 0.0% |
| 14 Intangible assets | - | 19.7 | Not Meaningful | 19.7 | Not Meaningful |
| 15 Other property & equipment, net | 19.7 | 1.0 | 5.0% | 2.0 | 10.0% |
| **Total Assets/Proceeds (A)** | **$ 940.6** | **$ 535.7** | **57.0%** | **$ 562.8** | **59.8%** |

14. **Intangible assets** include gates and arrival and departure slots, the Debtors' operating certificates, the Q400 Option Aircraft and the Debtors' Early Returns Frequent Flyer Program. These assets are not included on the Debtors' April 30, 2009 general ledger. The estimated recovery for the gates and arrival and departure slots is based on the American Appraisers appraisal report. The Debtors' and their advisors' knowledge of the airline industry were relied upon to determine recovery for the Debtors' operating certificate of Lynx Aviation and the Q400 Option Aircraft. No recovery is assigned to the Frontier operating certificate. It is possible that there is a recovery value for the Early Returns Frequent Flyer Program; however, a valuation has not been performed for the purpose of the Analysis. It is the Debtors' belief that any value ascribed would not materially alter the results of the Analysis.

## Panel C: Liquidation Analysis for Mesa Air Group, Inc

**Mesa Airlines, Inc. - Book Value of Assets as of June 30, 2010**

*($ in thousands)*

| | Net Book Value | Estimated Recovery Rate % | | Gross Proceeds | |
|---|---|---|---|---|---|
| | | Low | High | Low | High |
| Current assets: | | | | | |
| Cash and Equivalents | $49,500 | 100.0% | 100.0% | $49,500 | $49,500 |
| Marketable Securities | - | - | - | - | - |
| Restricted Cash | 10,458 | 0.0% | 0.0% | - | - |
| Receivables | 10,713 | 17.6% | 23.5% | 1,889 | 2,519 |
| Income Tax Receivable | - | - | - | - | - |
| Expendable Parts/Supplies | - | - | - | - | - |
| Prepaid Expenses | 86,933 | 4.4% | 5.0% | 3,832 | 4,380 |
| Deferred Income Tax | 3,778 | 0.0% | 0.0% | - | - |
| Total current assets | 161,382 | 34.2% | 34.9% | 55,221 | 56,398 |
| Flight Equipment | 450,668 | 0.1% | 0.2% | 554 | 739 |
| Other Property and Equipment | 26,737 | 24.5% | 34.5% | 6,557 | 9,230 |
| Lease & Equipment Deposits | 6,232 | 0.0% | 0.0% | - | - |
| Other Assets | 17,317 | 0.0% | 0.0% | - | - |
| I/C Investments | 263,803 | 0.0% | 0.0% | - | - |
| Non-Current Investments | - | - | - | - | - |
| Total | 926,139 | 6.7% | 7.2% | 62,332 | 66,368 |

Authors' Note: This liquidation analysis is for the main operating subsidiary in the Mesa Airlines consolidated group. The bankruptcy disclosure document presents liquidation analyses for several other subsidiaries, but they also have no book values or recoveries for intangible assets.

**Appendix 2: Variable Definitions**

| | |
|---|---|
| *Book Intan* | The book value of total intangibles (including goodwill), either from Compustat or bankruptcy firm's liquidation analysis. Table will specify the source of the on-balance-sheet intangibles. |
| *NGW Book Intan* | The book value of nongoodwill on-balance-sheet intangibles from the liquidation analysis or Compustat. Tables will specify. |
| *Book GW* | The book value of on-balance-sheet goodwill intangibles from the liquidation analysis or Compustat. Tables will specify. |
| *NGW Book Intan Indicator* | An indicator variable equal to one if the firm reports non-zero nongoodwill intangible assets on Compustat in that fiscal year, and zero otherwise. |
| *Off-BS Intan* | The estimated value of a firm's total off-balance-sheet intangible capital from Peters and Taylor (2017) dataset. |
| *Off-BS Know* | The estimated value of a firm's off-balance-sheet intangible knowledge capital (i.e., R&D intangibles) from Peters and Taylor (2017) dataset. |
| *Off-BS Org* | The estimated value of a firm's off-balance-sheet intangible organization capital (i.e., SG&A intangibles) from Peters and Taylor (2017) dataset. |
| *Total Intan* | The sum of *Book Intan* and *Off-BS Intan.* |
| *Intangible Recovery* | The dollar value of estimated mid-point recovery for intangible assets found in the bankruptcy liquidation analyses for each bankruptcy firm. |
| *Organization Off-BS Intangibles* | The estimated value of a firm's off-balance-sheet intangible capital from SG&A expense, from Peters and Taylor (2017) dataset. |

| | |
|---|---|
| *Knowledge Off-BS Intangibles* | The estimated value of a firm's off-balance-sheet intangible capital that arises from R&D expense, from Peters and Taylor (2017) dataset. |
| *Book Assets* | The book value of total assets on the balance sheet, either from Compustat or bankruptcy firm's liquidation analysis. Table will specify. |
| *Enterprise Value* | The sum of market equity from CRSP and total debt from Compustat. |
| *PP&E Ind Rate* | Two-digit SIC industry-averaged recovery rates for PP&E using K&M's original recovery rates. Calculated separately for each firm by excluding that firm's recovery rates from the industry average. |
| *PP&E Firm Rate* | The firm-level PP&E recovery rate from K&M's original dataset pulled from bankruptcy firm liquidation analyses. |
| *NGW Ind Rate* | Two-digit SIC industry-averaged recovery rates for nongoodwill intangibles using K&M's original recovery rates. Calculated separately for each firm by excluding that firm's recovery rates from the industry average. |
| *NGW Firm Rate* | The firm-level nongoodwill intangibles recovery rate from K&M's original dataset pulled from bankruptcy firm liquidation analyses. |
| *Error* | The difference between the actual intangible recovery value in the liquidation analysis and the estimated recovery value implied by applying K&M's original or our adjusted industry-average (or sample average) recovery rate. Errors are scaled either by the "Total Book Value" of assets included in the liquidation analysis (per K&M's original file) or by the sum of "Total Book Value" and *Off-BS Intan.* |
| *Absolute Error* | The absolute value of *Error.* |

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| *Squared Error* | The value of *Error* squared. |
| *Total Liquidation Value* | The sum of the estimated liquidation value of cash, receivables, inventory, PP&E, and intangibles for a given firm. Estimated by multiplying Compustat book values (or the sum of Compustat book values and off-balance-sheet intangibles) by the respective asset category's industry-average recovery rates. Recoveries for cash, receivables, inventory, and PP&E are calculated following Kermani and Ma (2023). Recoveries for intangibles are calculated two different ways: 1) following Kermani and Ma (2023), and 2) using our adjusted method.<br><br>See definition for *Intangibles Liquidation Value* for details on the two methods. |
| *Intangibles Liquidation Value* | The estimated liquidation value of intangibles for a given firm. This is calculated two different ways: 1) following Kermani and Ma (2023), and 2) using our adjusted method.<br><br>1) Compustat book intangibles minus goodwill, then multiplied by Kermani and Ma (2023) original nongoodwill intangibles recovery rate for that industry. If goodwill is missing, total book intangibles is multiplied by the combined intangibles recovery rate for that industry. If total intangibles are missing, a liquidation value of zero is assumed.<br><br>2) Compustat book intangibles plus P&T off-balance-sheet intangibles, multiplied by our adjusted combined intangibles recovery rate. Compustat book intangibles are filled with zero when it is missing but there is a positive P&T value. |
| *Leverage* | This is calculated in two different ways:<br><br>1) In regressions using K&M rates, calculated as the sum of short- and long-term debt scaled by Compustat total assets, multiplied by 100. |

| | |
|---|---|
| | 2) In regressions using our rates, calculated as the sum of short- and long-term debt scaled by the sum Compustat total assets and P&T off-balance-sheet intangibles, multiplied by 100.<br><br>In both ways, the variable is first calculated at the firm-year level and then averaged within two-digit SIC. |
| *Cash* | This is calculated in two different ways:<br><br>1) In regressions using K&M rates, calculated as cash and cash equivalents scaled by Compustat total assets, multiplied by 100.<br><br>2) In regressions using our rates, calculated as cash and cash equivalents scaled by the sum of Compustat total assets and P&T off-balance-sheet intangibles, multiplied by 100.<br><br>In both ways, the variable is first calculated at the firm-year level and then averaged within two-digit SIC. |
| *Gross Margin* | Sales minus cost of goods sold, scaled by sales and multiplied by 100. The variable is first calculated at the firm-year level and then averaged within two-digit SIC. |
| *K&M Non-Cash Recovery Rate* | The average non-cash recovery rate for firm-years within a two-digit SIC. Non-cash recovery rates include rates for receivables, inventory, PP&E, and intangibles. For each firm-year, each asset category K&M recovery rate is multiplied by the level of that asset category on the balance sheet and scaled by total Compustat assets. These weighted asset category recovery rates are then summed by firm-year. The average of all firm-years within two-digit SIC is then calculated. |
| *Our Non-Cash Recovery Rate* | The average adjusted non-cash recovery rate for firm-years within a two-digit SIC. Non-cash recovery rates include rates for receivables, inventory, PP&E, and intangibles. For each firm-year, each asset category |

| | |
|---|---|
| | recovery rate is multiplied by the level of that asset category on the balance sheet and scaled by the sum of total Compustat assets and P&T off-balance-sheet intangibles. For receivables, inventory, and PP&E, we use K&M's industry-level rates. For intangibles, we use our adjusted rates. These weighted asset category recovery rates are then summed by firm-year. The average of all firm-years within two-digit SIC is then calculated. |
| *WDP* | Compustat's pre-tax write-downs excluding goodwill and unamortized intangibles, scaled by lagged total assets. |
| *Abnormal WDP* | Compustat's pre-tax write-downs excluding goodwill and unamortized intangibles, scaled by lagged total assets, minus the average *WDP* for all Compustat firms in that fiscal quarter. |
| *GDWLIP* | Compustat's pre-tax write-downs goodwill, impairments of goodwill and other intangibles when combined, and impairments of unamortized intangibles, scaled by lagged total assets. |
| *Abnormal GDWLIP* | Compustat's pre-tax write-downs goodwill, impairments of goodwill and other intangibles when combined, and impairments of unamortized intangibles, minus the average *GDWLIP* for all Compustat firms in that fiscal quarter. |