Estimating a measure of intellectual capital value to test its determinants

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Abstract

Purpose – The purpose of this paper is to identify a measure of intellectual capital (IC) value which offers new research opportunities for empirical investigations and to examine the determinants of IC value.
Design/methodology/approach – In total, 4,488 firm years of German companies are investigated to compare three measures of IC value: market-to-book, Tobin's *q*, and long-run value-to-book (LRVTB).
Findings – LRVTB is observed to be the IC value measure with the highest explanatory value. This measure provides an approach to empirically test previously untested hypotheses on IC value. The results on testing determinants of IC value indicate that IC value is positively related to leverage and motivational payments to employees and negatively associated with company size. In contrast, recognised intangible assets, research and development (R&D), company age and concentrated ownership show no significant effects.
Research limitations/implications – The findings on IC value measures contribute to IC research as they offer a way to estimate IC value for testing IC-related hypotheses. The findings on IC determinants have implications for IC management as the relevant determinants can be considered for IC value creation.
Originality/value – This paper responds to the challenge posed by previous IC research to develop more creative quantitative approaches to estimate IC value (Marr *et al.*, 2003; Mouritsen, 2006) in order to test IC-related hypotheses by innovatively applying a measure from mergers and acquisitions research to IC.

Keywords Intellectual capital management, Intangibles, Intellectual capital, Long-run value
Paper type Research paper

Introduction

This study contributes to intellectual capital (IC) research by innovatively applying a measure from the area of mergers and acquisitions to IC research, which offers new research opportunities regarding IC value. Additionally, determinants of IC value are investigated. The findings on the IC value determinants contribute to IC management, as the development of IC value can be guided by focusing on the significant factors for IC value. This paper responds to the challenge posed by previous IC research to develop more creative quantitative approaches to estimate IC value (Marr *et al.*, 2003; Mouritsen, 2006). These previous studies argue that quantitative measures enhance testing IC-related hypotheses. This study compares three measures to examine which may best indicate IC value: market-to-book (MtB), Tobin's *q* and LRVTB. The IC value measure with the highest explanatory value in a regression of corporate performance is

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seen as the best estimator for IC value. This IC value measure is then used to examine IC value determinants.

First, 4,488 firm years of German companies, excluding financial companies, across three industry groups are investigated to estimate and compare the IC value measures. The LRVTB measure has been developed in mergers and acquisitions research (Rhodes-Kropf *et al.*, 2005). This study innovatively interprets LRVTB as a measure of IC value. The results suggest that LRVTB serves best to estimate IC value with the significantly highest explanatory power compared to MtB and Tobin's q. Second, LRVTB is applied to examine seven factors as potential determinants of IC value: intangible assets recognised on the balance sheet, expenses in R&D, motivational payments to employees, concentrated ownership, leverage, company age and company size. The hypotheses on the relationships of IC value with leverage and concentrated ownership have previously been untested.

The findings of this study contribute to the literature in several ways. On the one hand, the measure LRVTB adds to IC measurement research. On the other hand, the findings on IC value determinants contribute to IC management research. The results show that IC value is significantly positively related to leverage and motivational payments to employees and significantly negatively associated with size. Recognised intangible assets, R&D, company age and concentrated ownership have no significant associations with IC. The findings of this study can guide IC management in the creation of IC value. Accordingly, complex structures in big companies may reduce IC value but motivational payments to employees and influential lenders, monitoring IC investments, may support the development of IC value.

Literature review

IC as strategic advantage for corporate performance

Intangible resources have been argued to considerably contribute to competitive advantages and to corporate value creation (Hall, 1992; Sullivan, 1999). Initial studies on intangibles resources tried to describe this phenomenon (e.g. Brooking, 1996; Edvinsson and Malone, 1997; Roos *et al.*, 1997; Stewart, 1997; Sveiby, 1997). They established the concept of IC and highlighted its strategic importance. These studies have used different terminologies for the same underlying concept of IC, such as IC, intangible resources or intangibility. Particularly, the term "intangibles" may be unclear as it may denote intangible assets which are or should be recognised on the balance sheet (Skinner, 2008). On the other hand, some researchers refer to "intangibles" as all intangible resources (e.g. Lev, 2001; Villalonga, 2004), which is used synonymously with IC.

In a broad area of literature, IC is seen to equip the company with unique resources which cannot easily be imitated by competitors, representing a competitive advantage, being reflected in strong corporate performance and high company value (e.g. Hall, 1992; Stewart, 1997; Sveiby, 1997; Lev, 2001; Curado, 2008). Due to the competitive importance of IC, measures for IC value have been demanded to support IC research and hypothesis testing (Marr *et al.*, 2003; Mouritsen, 2006, 2009). However, no strong measure has been established. Some indicators of IC value have been established for IC management based on internal data but no approved overarching measures have been developed (Marr *et al.*, 2003). The underlying idea of this study is based on one major concept being consistent across different studies: IC is conceptualised to represent a strategic advantage for corporate performance. Based on surveys and questionnaires, Youndt *et al.* (2004) and Reed *et al.* (2006) find a positive relationship between IC profiles and performance in terms of profitability supporting the argument that companies with

more distinctive IC profiles generate higher returns compared to companies with less developed IC. According to this argument, companies with a high level of underlying corporate IC value are expected to perform well.

Approaches to measure IC value

Measuring IC value is problematic because IC is difficult to capture from corporate reporting (e.g. Guthrie and Petty, 2000; Lee and Guthrie, 2010; Zéghal and Maaloul, 2011; Guthrie *et al.*, 2012). Given limited data availability of IC-related information, the range of studies to examine the relationship between IC value and performance is narrow. This paper categorises the approaches to measure IC value in prior literature in three groups, depending on the information sources used: investment-based, component-based, and holistic market-based approaches.

Investment-based approaches rely on information provided in the income statement, considering IC-related expenses as investments. Pulic (1998) suggests the Value Added Intellectual Coefficient™ (VAIC™) as IC indicator. For this measure, labour expenses are argued to equate human capital as an investment rather than an expense. However, this paper argues that VAIC™ is flawed due to two major weaknesses. First, if human capital is seen as an investment, the question arises, whether it would have to be added to capital employed. Second, Pulic's (1998) residual approach assumes that all operating expenses are related to IC, which may not hold. Despite these flaws, IC studies have worked with VAIC™ but their results may be weak (e.g. Williams, 2001; Nazari and Herremans, 2007; Kamath, 2008; Zéghal and Maaloul, 2010; Maditinos *et al.*, 2011). Ståhle *et al.* (2011) even argue that the VAIC™ measure does not represent IC at all. Another investment-based measure for IC value is organisation capital, indicated by the expense category selling, general and administration (Lev and Radhakrishnan, 2005; Lev *et al.*, 2009). Organisation capital is described as an efficiency measure for investments on employees, systems, brands, etc. Inconsistencies in the estimation procedures in the two studies hamper an understanding of what organisation capital essentially measures or how it can be interpreted.

Component-based measures are based on individual IC components with contradicting views. Interactions of IC components are seen to contribute considerably to IC value (van der Meer-Kooistra and Zijlstra, 2001). However, these unobservable interactions are omitted in a measure which focuses on individual components (Mouritsen, 2009). The component-based approach is not often used in prior studies, probably because quantitative information on individual IC components is rarely published. In the area of market valuation research, Pantzalis and Park (2009) investigate human capital with a ratio of market value over the total number of employees compared to an industry. However, the number of employees only represents one aspect of human capital, not considering education and training. Hence, the human capital measure by Pantzalis and Park (2009) provides an indication of personnel input to generate market value rather than human capital.

Holistic market-based approaches assume that the market incorporates IC value beyond the financial statements (e.g. Sveiby, 1997). The focus is on the holistic effect of IC value on the company value, where interactions between IC components are captured in the overall value. IC investments result in higher generated earnings with an effect on company value, as argued by Penman (2009), even if they go beyond financial reporting. Therefore, this study considers holistic market-based approaches to be most suitable to capture IC value. The disparity between market value and book value, represented in MtB ratios above one, has been suggested to indicate IC value

(e.g. Stewart, 1997; Sveiby, 1997). However, some weaknesses of MtB as an estimator of IC value have been discussed. Brennan and Connell (2000), supported by Dumay (2012), criticised MtB ratios as indicators of IC value, stating two major weaknesses: historic cost accounting and market value fluctuations.

Hypothesis development

Addressing weaknesses of MtB as measure of IC value

One reason, why market values diverge from book values, is historic cost accounting (Brennan and Connell, 2000; Dumay, 2012). To address this issue, Tobin's *q* has been used to indicate IC value. Villalonga (2004) found that Tobin's *q* may approximate IC value. Tobin's *q* attempts to provide a ratio of market value over replacement values of tangible assets, subject to assumptions (Lindenberg and Ross, 1981; Smirlock *et al.*, 1984). With the underlying assumptions, Tobin's *q* may partially reduce the distortion of MtB rather than representing an accurate measure of IC value. Nevertheless, the adjustments of historic costs to replacement costs may improve the measure for the purpose of indicating IC value. Therefore, the first hypothesis is stated as follows:

H1. The explanatory power of Tobin's *q* regarding corporate performance is higher than of MtB to serve as a measure of IC value.

As fluctuations in market values may distort estimations of IC value, excess market values may not be completely attributable to IC value; hence, MtB as IC value measure may be flawed. In interviews with managers, van der Meer-Kooistra and Zijlstra (2001) found that corporations also consider MtB ratios as insufficient indicators, arguing that temporary fluctuations in market values may coincide with unchanged levels of IC value. Accordingly, IC measures based on MtB capture additional short-run considerations besides IC value. In order to reduce the weakness of market fluctuations in MtB ratios, this study conducted a search for potential measures going beyond the IC literature. In the area of mergers and acquisitions research, company values are investigated based on merger and acquisition events which provide additional information to estimate long-run growth opportunities and intrinsic company values (e.g. Rhodes-Kropf *et al.*, 2005). As IC is argued to represent a cornerstone of corporate performance and strategic advantage to support sustainable value development, IC value corresponds to the views of intrinsic company values. Following this line of thought, this study suggests that the described characteristics of LRVTB are similar to the characteristics of IC value as strategic advantage. According to the initial idea of IC to constitute a competitive advantage, IC can also be seen to represent sustainable growth opportunities. Therefore, this study innovatively applies the LRVTB measure to the area of IC research.

In their approach to examine long-run intrinsic corporate value, Rhodes-Kropf *et al.* (2005) decompose the MtB ratio into three components: firm-specific error, time-series sector error and LRVTB. The first two components refer to mispricing of individual companies and industries whereas the latter is argued to indicate long-term growth opportunities. The results of Hertzel and Li (2010) are consistent with the interpretation by Rhodes-Kropf *et al.* (2005) that LRVTB represents long-run growth options. The LRVTB component is estimated as the intrinsic company value after accounting for market fluctuations due to mispricing. Mispricing is seen as the deviation of the company's market value from its underlying long-run intrinsic value (Doukas *et al.*,

2010; Hertzel and Li, 2010; Rhodes-Kropf *et al.*, 2005). The long-run value component of MtB as a potential measure for IC value is interesting for this study. The LRVTB measure is worth reviewing for estimating IC value as it addresses the weakness of market fluctuations inherent in MtB. Based on this argument, this study interprets LRVTB as underlying corporate IC value and extends the application of LRVTB to serve as a novel measure of IC value. The interpretation of LRVTB as IC value measure stimulated the second hypothesis:

H2. The explanatory power of LRVTB regarding corporate performance is higher than of MtB to serve as a measure of IC value.

Potential determinants of IC value

The hypotheses regarding IC value determinants are developed from a broader IC literature. Some potential determinants of IC value can be found in the IC information available in the financial statements. Villalonga (2004) tried to measure IC by using R&D, advertising, and intangible assets recognised on the balance sheet. According to her results, these three analysed IC elements seem to be important components in determining IC value. However, information on advertising expenses is rarely available and cannot be generally investigated. The association of IC value with recognised intangible assets and R&D is tested with the following hypotheses:

H3. Recognised intangible assets are positively associated with IC value.

H4. Corporate R&D expenses are positively associated with IC value.

Furthermore, motivational payments may contribute considerably to IC value because competitive payments may serve as motivation for employees to prevent a movement of labour and increase productivity, as argued by Groshen (1991). This effect has been found to be significant in a study on organisational capital by Ludewig and Sadowski (2009). They compare a company's average payment per employee, based on salary expenses in the income statement, with the industry average to obtain a ratio of motivational payment. The relationship of IC value and motivational payments to employees is tested in the following hypothesis:

H5. Motivational payment is positively associated with IC value.

The ownership structure is another potential determinant of IC value. German companies offer an interesting setting for investigating this previously untested aspect because, historically, ownership concentration has been high with large block holders in Germany, outlined by Dignam and Galanis (2009). As the association of the ownership structure with IC value has been previously untested, this hypothesis is based on the conceptual study by Keenan and Aggestam (2001). However, the effect of concentrated ownership on IC value is not clear from their conceptual discussion. On the one hand, block holdings may focus on stability rather than innovation which may constrain IC development. On the other hand, widely spread owners may lack the ability to effectively govern IC, resulting in a lower level of IC value. Without specifying the expected direction of association, the relationship between ownership concentration and IC value is hypothesised as follows:

H6. Ownership concentration is associated with IC value.

Lenders may represent influential stakeholders, with increasing debt to equity ratios, to affect IC value. This may be particularly distinctive for insider governance systems, dominant in countries such as Germany and Japan, as discussed by Dignam and Galanis (2009), where lenders have strong influential power. Keenan and Aggestam (2001) argue that these influential stakeholders may increase the fiduciary responsibility to monitor IC investments. Therefore, companies may be forced to manage their IC more actively. Hence, the development of IC value may be accelerated and its utilisation may be supported with a strong influential position of lenders. This view on the influential position of lenders and IC value leads to the following hypothesis, which has been previously untested:

H7. Leverage is positively associated with IC value.

Firm age is seen to be an influential factor as companies develop IC value over time due to an accumulative effect (Nahapiet and Ghoshal, 1998). Particularly, the management literature has investigated this relationship with inconclusive results. In a study on corporate IC profiles, Youndt *et al.* (2004) find no significant influence of company age. Reed *et al.*'s (2006) results suggest that age has a significant influence for one panel in their sample. According to their findings, company age seems to positively affect IC value for personal banks but not for commercial banks. However, an explanation is missing why age may significantly influence IC value for a certain group of banks. The argument that company age may impact on IC value is stated in the following hypothesis:

H8. Company age is positively associated with IC value.

Company size may also have an influence on the corporate level of IC value. The effect of company size on IC value has rarely been investigated in the IC literature. However, Lev (2001) mentions size advantages with regards to economies of scale in the area of R&D and favourable networks. Moreover, Youndt *et al.* (2004) suggest that company size may positively influence IC value due to advantageous access to resources and market power. Their findings show that the influence of company size on IC value is positive but not significant. Reed *et al.* (2006) find a significant positive effect of size on IC value in both panels of personal and commercial banks. However, as their sample is limited to the banking sector this result may not be generalisable. The proposition that IC value may increase with company size is tested in the final hypothesis:

H9. Company size is positively associated with IC value.

Research design

Sample of German companies and industry grouping

The total sample comprises 6,627 firm years of companies listed on the German stock exchange between 2000 and 2010, excluding companies operating in the financial sector. For the comparison of IC value measures the sample is reduced to 4,488 cases due to data availability for estimating all three measures of IC value: MtB, Tobin's q and LRVTB. This enables a comparison of explanatory values between the different approaches to measure IC value for the same companies. Germany offers interesting research opportunities for IC value measures because Germany is found to be a country with relatively high national IC in an international comparison conducted by Lin and Edvinsson (2010). As IC constitutes a competitive advantage, competing companies

within the same industry may aim to develop similar IC components under similar economic circumstances. Therefore, the sample is divided into three industry groups: consumer, pharmaceutical and technology, and industrial.

Estimating MtB

For estimating MtB ratios, the variety of German shares needs to be considered. German companies have a variety of shares which represent ordinary shares, constituting equity. As some shares are unlisted, a simple summation of the market values of individual shares to arrive at the actual market value of equity for German companies is impossible. Hence, the Datastream item "Market value, consolidated (MVC)" provides a solution to this problem as it considers all shares with equity characteristics. To estimate MtB, this study calculates the market value of all equity shares, represented by MVC, divided by the book value of equity on the balance sheet including the equivalent book value of all equity shares.

Estimating Tobin's q

For this study, Tobin's q as a ratio of market value to replacement costs is calculated in accordance with Villalonga (2004) based on Lindenberg and Ross (1981) and Smirlock *et al.* (1984). Corporate data is taken from Datastream and information on price indices from Eurostat. Applied assumptions are zero technological progress, to simplify calculations, and 10 per cent depreciation, to account for a variety of depreciation methods. For inventory accounting, the average cost method is assumed to be followed by all companies according to IAS 2. Replacement costs of assets are assumed to equal book values for the year 2000 or the first year the company appears in Datastream. Additionally, net book values of property, plant and equipment are assumed to represent the minimum replacement costs if the computed replacement costs of plant, property and equipment after disinvestments result in negative values, which seems implausible.

Estimating LRVTB

For this study, the long-run value component LRVTB of MtB as a potential measure for IC value is of interest. Rhodes-Kropf *et al.* (2005) suggest three models to estimate the MtB components in a sequence of regression analyses. The three models subsequently add more accounting information in the regressions. As only accounting information on book value of equity and income are required for models 1 and 2, they have less data requirements than model 3. This study applies model 2 by Rhodes-Kropf *et al.* (2005) to estimate LRVTB with book value of equity and income as accounting information. The market value of the company is taken for the date three months after the financial year end, according to the approach by Rhodes-Kropf *et al.* (2005), to account for a delay in publishing the accounting information. To be directly comparable to the ratio measures MtB and Tobin's q, LRVTB is transformed into ratios by antilogarithms. The antilog of LRVTB can be interpreted as a ratio of a company's long-run value to its book value.

Additional considerations when measuring IC value

The review of approaches to measure IC value shows that IC value is difficult to capture. Mouritsen (2009) even argues that it is impossible to measure IC value in monetary terms but it is important to understand how to estimate relative levels of IC value. According to his argument, estimating levels of IC value rather than monetary

values facilitates testing IC-related hypotheses. Based on this view, this study suggests grouping the IC value measures into relative levels of IC value to enable comparisons of the different measures.

Furthermore, this study suggests that, with regards to corporate performance in the comparison of IC value measures, IC value should be examined with a lagged effect, as IC value affects performance for several years to come. The lagged effect has been rarely tested. Chen *et al.* (2005) conduct several analyses with potential measures of IC value lagged for one, two or three years. Their similar results provide no indication on what lag length is suitable. The findings by Lev *et al.* (2009) also indicate that IC value affects future performance without specifying a time period. IC value at the end of a financial year is readily available to be used to support performance in the following period but in the future corporate IC value may be outdated or lost. As the optimal length of lags cannot be concluded, this study assumes that performance is supported by IC value with a lag of one year.

Regression model to compare IC value measures

The relationship between IC value and performance is a basic assumption of this study, enabling the innovative comparison of different IC value measures. Corporate performance in terms of profitability is regressed on the three suggested IC value measures: MtB, Tobin's q and LRVTB. The linear regression models are compared regarding their explanatory powers. This comparison allows investigating whether the measures Tobin's q and LRVTB serve as better estimators of IC value than MtB. As IC has been found to positively impact on corporate performance in terms of profitability (Reed *et al.*, 2006; Youndt *et al.*, 2004), the measure that best explains the relationship to corporate performance can be interpreted as best estimator of IC value. In accordance with prior literature, performance is measured in terms of profitability as return on equity (ROE) and return on assets (ROA). The two performance measures are ranked, controlling for year and industry.

The IC value measures are grouped into deciles to analyse different levels of IC value rather than monetary value. Industry and year are controlled for in the deciles, equivalent to the performance rankings. Company size serves as control variable. In the model, the rank of performance measures are regressed on lagged levels of IC, represented as deciles of IC value measures, as performance is generated by utilising previously developed IC value. The deciles of IC value measures are interacted with the dummy variables of the three industry groups. This interaction, rather than control variable, illustrates how IC value affects performance in different industries as industry is already accounted for in performance ranks and deciles of IC value. The regression, illustrated in equation (1), is clustered by company. Table I shows definitions and descriptive statistics of the variables:

$$performance_t = \beta_0 + \beta_1\, level\ of\ IC_{t-1} \times \sum \alpha_i\, industry_j + \beta_2\, size_j + \varepsilon_j \qquad (1)$$

Vuong's closeness test to test hypotheses on IC value measures

As this study innovatively compares measures of IC value, a reasonable way has to be found to differentiate between the suitability of the measures. This study compares the measures in terms of their explanatory values for the regression model. To test hypotheses *H1* and *H2*, Vuong's closeness test is applied to investigate whether the differences in explanatory power, R^2, of the regression modifications are significant. Vuong's closeness test is based on likelihood ratios to identify which model is closer to

Table I.
Descriptive statistics for the analysis of IC value measures

Panel A: definitions of variables

Variable	Definition	Function
ROE	Rank of return on equity, controlled for industry+year	Dependent variable
ROA	Rank of return on assets, controlled for industry+year	Dependent variable
deciles MtB	Deciles of MtB ratios controlled for industry and year	Test *H1+H2*
deciles Tobin's q	Deciles of Tobin's q controlled for industry and year	Test *H1*
deciles LRVTB	Deciles of LRVTB controlled for industry and year	Test *H2*
size	Natural logarithm of total assets	Control variable
industry	Dummy for industry groups: consumer, pharmaceutical and technology, industrial	Interaction to illustrate industry outcome

Panel B: descriptive statistics

	n	Mean	SD	Min	Max
ROE	4,417	68.73	40.57	1.00	162.00
consumer	1,605	73.77	42.67	1.00	162.00
pharma and tech	1,321	62.29	37.10	1.00	138.00
industrial	1,491	69.02	40.43	1.00	159.00
ROA	4,441	69.11	40.80	1.00	162.00
consumer	1,616	74.25	42.93	1.00	162.00
pharma & tech	1,325	62.49	37.22	1.00	138.00
industrial	1,500	69.43	40.66	1.00	159.00
deciles MtB	4,488	5.47	2.87	1.00	10.00
deciles Tobin's q	4,488	5.47	2.87	1.00	10.00
deciles LRVTB	4,488	5.38	2.86	1.00	10.00
size	4,488	11.85	2.11	4.70	19.17

(*continued*)

Table I.

Panel C: correlations

	Total		Consumer		Pharma and Tech		Industrial	
	P	S	P	S	P	S	P	S
				ROE				
deciles MtB	0.22*	0.21*	0.24	0.24*	0.13*	0.12*	0.26*	0.26*
deciles Tobin's q	0.23*	0.23*	0.27*	0.27*	0.16*	0.15*	0.25*	0.25*
deciles LRVTB	0.40*	0.39*	0.40*	0.39*	0.26*	0.24*	0.51*	0.50*
size	0.24*	0.26*	0.26*	0.28*	0.20*	0.22*	0.23*	0.23*
				ROA				
deciles MtB	0.19*	0.18*	0.21*	0.20*	0.13*	0.12*	0.22*	0.22*
deciles Tobin's q	0.25*	0.24*	0.28*	0.28*	0.18*	0.17*	0.26*	0.26*
deciles LRVTB	0.37*	0.36*	0.38*	0.37*	0.25*	0.23*	0.46*	0.45*
size	0.16*	0.20*	0.17*	0.21*	0.17*	0.19*	0.11*	0.13*

Notes: These tables show definitions (Panel A), descriptive statistics (Panel B), and correlations (Panel C) for the regression analysis of IC value measures. In the correlation table columns P show Pearson and columns S Spearman correlations for ROE or ROA. The correlations are low and do not imply multicollinearity. *Significant at 5 per cent level

the real model (Vuong, 1989). If the null hypothesis is rejected, one model has a significantly higher explanatory value compared to the competing model.

Testing hypotheses on determinants of IC value

The comparison of IC value measures provides the estimator for IC value with high explanatory power. This identified measure is then used as dependent variable in a linear regression to test potential determinants of IC value. As developed in hypotheses *H3* to *H9*, seven different factors are tested: recognised intangible assets, R&D expenses, motivational payments to employees, concentrated ownership, leverage, company age and company size. To account for differences in IC across industries, industry serves as control variable. The regression is shown in Equation (2) and is clustered by companies. Table II shows definitions and descriptive statistics of the variables:

$$IC_j = \beta_0 + \beta_1\, intangibles_j + \beta_2\, R\&D_j + \beta_3\, payment_j + \beta_4\, ownership_j + \beta_5\, leverage_j + \beta_6\, age_j + \beta_7\, size_j + \sum \alpha_i\, industry_j + \varepsilon_j \quad (2)$$

Results

Descriptive results for IC value measures

The three IC value measures are calculated for a sample of 4,488 firm years of German companies. For all three ratios, a value above 1 indicates underlying corporate IC value. Table III shows the descriptive results of the three IC value measures for each industry. The mean value is above 1 across all industry groups for all three measures. This result suggests that IC value exists in the majority of German companies. In comparison, MtB takes the highest values in all industries with the highest standard deviations. Hence, MtB is the most volatile measure for IC value and reveals big discrepancies between market values and book values. These discrepancies may be due to the discussed weaknesses of historic cost accounting and market price fluctuations. For Tobin's *q* the mean values and standard deviations are lower than for MtB. The same is true for the antilog of LRVTB. With regards to the mean values, Tobin's *q* seems to be lowest but LRVTB shows the smallest standard deviations.

Regression results of comparing IC value measures

To identify the IC value measure with the best explanatory value, a regression analysis is conducted for corporate performance in terms of profitability. The regression results are shown in Table IV with different model specifications in columns (1)-(6), clustered by company. While in columns (1)-(3) ranked ROE is regressed on deciles of MtB, Tobin's *q* and LRVTB, in columns (4)-(6) ranked ROA serves as performance measure. Performance ranks and deciles of IC value measures are controlled for industry and year in the ranking and grouping procedures. If industry is not controlled for in the rankings and groupings, the results may differ due to industry-specific facets of IC. Significant results for the interaction terms between lagged IC value measures and industry groups provide information on how much the ranking of performance differs for a higher level of IC value within a certain industry. For increasing levels of IC value, a company's performance rank rises significantly for both performance measures and all IC value measures. These results show by how much the company's performance rises in the ranking with an increase in IC value by one decile for each IC value

Table II.
Descriptive statistics for determinants of IC value

Panel A: definitions of variables

Variable	Definition	Function
IC value	Antilog of LRVTB as measure of IC value	Dependent variable
intangibles	Intangible assets scaled by total assets	Test hypothesis *H3*
R&D	Dummy variable: 1 if R&D expenses declared, 0 otherwise	Test hypothesis *H4*
payment	Dummy variable: 1 if payments per employee above industry average, 0 otherwise	Test hypothesis *H5*
ownership	Percentage of shares held by family members and employees	Test hypothesis *H6*
leverage	Percentage of debt to total capital	Test hypothesis *H7*
age	Company age as years since company was founded	Test hypothesis *H8*
size	Natural logarithm of total assets	Test hypothesis *H9*
industry	Dummy for industry groups: consumer, pharmaceutical and technology, industrial; consumer as base industry	Control variable

Panel B: descriptive statistics

	Continuous variables					Dummy frequency	
	n	Mean	SD	Min	Max	0	1
IC value	4,488	1.80	0.74	0.23	17.17		
intangibles	4,474	0.15	0.17	−0.10	0.95		
R&D	4,488					2,731	1,757
payment	4,219					2,498	1,721
ownership	2,986	19.75	25.37	0.00	98.00		
leverage	4,442	53.98	22.81	0.33	99.99		
age	4,488	49.24	51.39	0.00	269.00		
size	4,488	11.85	2.11	4.70	19.17		

(*continued*)

Table II.

Panel C: correlations

	IC value	*intangibles*	*R&D*	*payment*	*ownership*	*leverage*	*age*	*size*
IC value	1	−0.01	−0.07*	0.06*	0.03	0.14*	−0.09*	−0.17*
intangibles	−0.03	1	0.05*	0.03	0.01	0.00	−0.27*	−0.01
R&D	−0.12*	0.01	1	0.11*	−0.05*	−0.08*	0.08*	0.27*
payment	0.04*	0.05*	0.10*	1	−0.01	−0.07*	−0.02	−0.03
ownership	0.02	−0.02	−0.06*	−0.01	1	−0.10*	−0.17*	−0.20*
leverage	0.22*	−0.04*	−0.08*	−0.09*	−0.10*	1	0.29*	0.35*
age	−0.06*	−0.27*	0.06*	−0.01	−0.19*	0.34*	1	0.42*
size	−0.24*	−0.03*	0.30*	0.01	−0.17*	0.35*	0.41*	1

Notes: These tables show definitions (Panel A), descriptive statistics (Panels B) and correlations (Panel C) of variables in the regression analysis of determinants of IC value. In the correlation table, Pearson correlations are given in the lower left-hand corner and Spearman correlations are shown in the upper right-hand corner. The correlation level between the regression variables is low and does not imply multicollinearity. *Significant at 5 per cent level

		MtB	Tobin's q	LRVTB
Total	Mean	3.29	1.52	1.80
$n = 4{,}488$	SD	26.69	1.34	0.74
	Min	0.07	0.23	0.23
	Max	1,620.00	25.46	17.17
Consumer	Mean	3.52	1.47	1.87
$n = 1{,}631$	SD	16.49	1.32	0.80
	Min	0.07	0.28	0.28
	Max	373.56	25.46	10.38
Pharmaceutical and technology	Mean	2.86	1.69	1.79
$n = 1{,}346$	SD	9.41	1.64	0.73
	Min	0.11	0.23	0.27
	Max	269.55	23.61	9.90
Industrial	Mean	3.42	1.42	1.74
$n = 1{,}511$	SD	41.77	1.01	0.67
	Min	0.11	0.35	0.23
	Max	1,620.00	11.46	17.17

Table III.
Descriptive results of IC value measures

Notes: This table shows descriptive results of the IC value measures MtB, Tobin's q and antilog of LRVTB computed for a sample of German companies of 4,488 firm years grouped into three industries. Ratios above the value of 1 indicate underlying corporate IC value

	ROE			ROA		
	(1) MtB	(2) Tobin's q	(3) LRVTB	(4) MtB	(5) Tobin's q	(6) LRVTB
constant	−7.656	−10.328*	−24.346***	15.008**	9.371	−1.657
	(−1.34)	(−1.82)	(−4.26)	(2.24)	(1.46)	(−0.25)
lagged deciles of IC measures						
consumer	4.809***	4.533***	5.607***	4.273***	4.625***	5.322***
	(11.64)	(11.32)	(14.37)	(9.76)	(10.62)	(13.24)
pharma and tech	3.653***	3.408***	4.620***	3.019***	3.308***	4.102***
	(8.58)	(7.77)	(12.46)	(6.83)	(7.16)	(10.74)
industrial	3.523***	3.166***	4.314***	3.203***	3.487***	4.201***
	(8.19)	(7.15)	(10.31)	(6.69)	(7.25)	(9.15)
size	4.685***	5.032***	5.708***	3.015***	3.336***	3.947***
	(9.76)	(10.63)	(12.04)	(5.47)	(6.30)	(7.14)
Model summary						
R^2	0.151	0.141	0.184	0.097	0.110	0.136
Adj. R^2	0.150	0.140	0.183	0.096	0.109	0.135
n	3,654	3,654	3,654	3,654	3,654	3,654

Table IV.
Regression results for measures of IC value

Notes: This table shows the results for the regression analysis for IC value measures, clustered by company. The dependent variable for performance is measured as the rank of ROE or ROA, controlled for industry and year. t-statistics are given in parenthesis underneath values for coefficients. Columns (1)-(6) represent different model specifications using different measures for corporate performance and IC value. *,**,***Siginificant at 10, 5 and 1 per cent levels, respectively:

$$performance_t = \beta_0 + \beta_1\, level\ of\ IC_{t-1} \times \sum \alpha_i industry_j + \beta_2 size_j + \varepsilon_j$$

measure. To test for robustness, the analysis was also conducted with no lag and a lag of two years for the relationship of IC value and corporate performance. As the results were similar with regards to the comparison of IC value measures, they are not further considered in this study.

Results for Vuong's closeness test for IC value measures

A comparison of the regression results for the different IC value measures allows investigating hypotheses *H1* and *H2*. The significance in the difference between R^2 for the models is tested using Vuong's closeness test, shown in Table V. The findings suggest that the regression models with LRVTB perform significantly better compared to MtB and Tobin's *q* for both performance measures. The models with Tobin's *q* show inconsistent results, as Tobin's *q* is significantly outperformed by MtB for ROE but performs significantly better than MtB for ROA. Therefore, the results are inconclusive for *H1* as Tobin's *q* does not add explanatory power compared to MtB for ROE but for ROA. *H2* is supported and LRVTB outperforms MtB and Tobin's *q* in terms of explanatory power for both performance measures. Compared to MtB and Tobin's *q*, LRVTB has the highest explanatory values in the regression analyses on corporate performance in terms of profitability. Hence, this study interprets LRVTB to serve as best estimator for IC value. This innovatively applied LRVTB measure of long-run value offers new opportunities for IC research as the most applicable measure of IC value.

Results for testing hypotheses on determinants of IC value

As LRVTB is identified to be the best estimator of IC value, compared to MtB and Tobin's *q*, this study applies LRVTB to examine potential IC value determinants. Table VI shows the results for the regression analysis on the determinants of IC value, clustered by company, with the antilog of LRVTB as dependent variable for IC value. Significant results indicate which company characteristics are associated with IC value.

The results suggest that three out of seven variables are significantly associated with IC value. These factors are motivational payments to employees (*H5*), leverage (*H7*) and company size (*H9*). However, the relationship of size (*H9*) is in contrast to the expectation, contradicting *H9*. A potential reason is that bigger companies may lose efficiency for creating IC value in complex structures. Motivational payments to employees (*H5*) and leverage (*H7*) are significantly positively related to IC value,

	R^2 for model with			Vuong	
	MtB	Tobin's *q*	LRVTB	*z*-statistic	*p*-value
Model with ROE	0.151	0.141		2.253	0.024**
	0.151		0.184	−3.040	0.002***
		0.141	0.184	−3.793	0.000***
Model with ROA	0.097	0.110		−3.123	0.002***
	0.097		0.136	−3.847	0.000***
		0.110	0.136	−2.353	0.019**

Notes: This table shows the results of Vuong's closeness test for comparing R^2 of different regression models for IC value measures (see Table IV). The results support *H2* but are inconclusive for *H1*. *,**,***Significant at 10, 5 and 1 per cent levels, respectively

Table V. Results for Vuong's closeness test

	Coefficients	*t*-statistics
constant	2.390	17.47***
intangibles	−0.124	−1.27
R&D	0.014	0.39
payment	0.090	2.73***
ownership	0.000	−0.71
leverage	0.012	8.84***
age	−0.001	−1.31
size	−0.101	−7.28***
industry		
pharma and tech	0.094	1.80*
industrial	−0.051	−1.08
Model summary		
R^2	0.146	
Adj. R^2	0.144	
n	3,484	

Notes: This table shows results for the regression analysis of determinants of IC value. The dependent variable IC value is measured as the antilog of LRVTB, clustered by companies. *,**,***Significant at 10, 5 and 1 per cent levels, respectively:

$$IC_j = \beta_0 + \beta_1 intangibles_j + \beta_2 R\&D_j + \beta_3\, payment_j + \beta_4 ownership_j + \beta_5 leverage_j + \beta_6 age_j + \beta_7 size_j + \sum \alpha_i industry_j + \varepsilon_j$$

Table VI.
Regression results for determinants of IC value

supporting *H5* and *H7*. The positive association of motivational payments with IC value is consistent with Ludewig and Sadowski's (2009) study on organisational capital. The relationship between leverage and IC value has been previously untested. The significant positive relationship may be particularly significant for Germany as a country with high leverage ratios in an insider governance system, as outlined by Dignam and Galanis (2009). Hence, lenders have great influential powers which may encourage active monitoring of IC investments and management of IC value.

The results provide no evidence to support hypotheses *H3*, *H4*, *H6* and *H8*. Recognised intangible assets (*H3*) and R&D (*H4*) are not associated with IC value. As information on R&D and intangible assets is disclosed in the financial statements, the market may consider these items differently without contributing to IC value represented in a holistic market-based measure of exceeding market values. As the relationship between concentrated ownership and IC value has been previously untested, this study developed hypothesis *H6* based on the conceptualisation by Keenan and Aggestam's (2001). The findings of this study could not support the concept in either direction. With regards to hypothesis *H8* on company age, the non-significant result is consistent with the findings by Youndt *et al.* (2004).

Conclusion

The aims of this study are to identify the IC value measure with the highest explanatory value in a regression of corporate performance out of three estimators and use this measure to examine determinants of IC value. As this study argues that holistic measures capture IC value more comprehensively, this study chose three holistic market-based measures: MtB, Tobin's *q* and LRVTB. The criticism of MtB as estimator of IC value has initiated the hypotheses to test whether MtB, Tobin's *q* or LRVTB serve

best to estimate IC value. The three IC value measures are estimated and the explanatory power of the three measures is compared in a regression analysis for their association with corporate performance. To test the hypotheses on IC value measures, Vuong's closeness test is applied. The findings identify LRVTB to be the best IC value estimator. This measure from the research area of mergers and acquisitions offers new research opportunities for empirically investigating IC value.

The hypotheses on IC value determinants are partly based on conceptual studies because the relationships of IC value to leverage and concentrated ownership have been previously untested. The findings suggest that IC value is significantly positively associated with motivational payments to employees and with increasing leverage ratios. The significant positive relationship between IC value and motivational payments to employees corresponds with the findings by Ludewig and Sadowski (2009) on organisational capital. The significant positive association of leverage with IC value supports the conceptual relationship between IC value and the position of lenders as influential stakeholder, suggested by Keenan and Aggestam (2001). In contrast to the hypothesised effect of size, bigger companies seem to have a significantly lower level of IC value. A potential reason for the significant negative relation of IC value and size may be that the creation of IC value is more difficult with increasing size and complex structures. Other factors are found to be non-significant for IC value: recognised intangible assets, R&D expenses, concentrated ownership, and company age.

This study has implications for researchers and practitioners. The innovative approach to IC value measures, applied in this study, contributes to the area of IC research, particularly IC measurement. This approach motivates further empirical research on IC value from new perspectives. Regarding the analysis of IC value determinants, the results indicate that IC value is significantly positively related to motivational payments to employees and leverage and significantly negatively associated with size. These findings contribute to strategies for managing and developing IC value.

The study is subject to limitations. The study innovatively compares three measures of IC value based on the best explanatory value for corporate performance. The LRVTB measure is newly applied as an estimator of IC value but additional investigations to further explore how LRVTB could serve as predictive measure of IC value may support a deeper understanding of this IC value measure. The relationship between performance and IC value measures is assumed to be lagged by one year in this study. This relationship requires further investigations as the long-term development of IC value may justify longer lags. Additionally, some findings may dominate a German sample, such as the association of leverage with IC value because the influential power of lenders may be strong in the German insider governance system.

The results of this study offer suggestions for future research. An interesting research area is the unexpected significantly negative relationship between IC value and size. The reasons why bigger companies have a lower level of IC value may be interesting for management purposes to more actively engage with IC according to size requirements. Further research could examine in detailed investigations, such as case studies, whether the size effect is related to international activities or more complex internal structures. With regards to the findings on leverage, further insights into the monitoring effect on IC value by influential stakeholders, such as lenders, may enhance IC management. The wide range of further research opportunities, offered by the newly identified IC value measure, is unlimited. Creative research questions are highly encouraged to better understand IC value through empirical investigations to further enhance effective IC management.

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