Measuring intellectual capital using VAIC and M-VAIC models on a sample of DAX30 companies

Abstract

The paper deals with the issue of intellectual capital and its recognition in relation to financial statements prepared in accordance with IFRS. First, value added is characterised. Subsequently, value added is used to construct and analyse the VAIC and modified M-VAIC ratios. The research part is devoted to the analysis of the relationship between VAIC, or modified M-VAIC respectively, and the performance of entities measured through MV/BV and ROE on a sample of companies from the DAX30 index during 2011-2018. The pooling OLS method was used as it has a higher predictive power than random and fixed effect methods. Based on the results of the analysis, it was concluded that there exists a significant relationship between modified M-VAIC and MV/BV, or ROE respectively. Of the four hypotheses, two were neither confirmed nor rejected, one was confirmed, and one was rejected.

Keywords

Intellectual capital; IFRS; VAIC; Value added; IAS38; IFRS5; Intangible Assets; M-VAIC

Introduction

The conceptual framework of International Financial Reporting Standards (IFRS) states that the objective of financial reporting is to provide financial information about an entity that is useful to current and potential investors and creditors in making decisions about providing capital to the entity (PFK International, 2019). Following this primary objective, the both the regulation of financial reporting and the construction of financial statements is subordinated to this objective. However, it should be added that financial accounting outputs are used also by others than those directly providing financial capital. Employees, public authorities, the media, and the general public can serve as an example. The disclosure of financial information is based on the assumption that the majority of users need similar information and thus, information is disclosed in a consistent manner. Nevertheless, if information requirements were different, a uniform presentation of information would not satisfy information needs and entities would be motivated to present information differently to various users (Benjamin and Stanga, 1977). A fact that has been significantly evident in the evolution of entity reporting is the inability to capture the essential characteristics of an entity in traditionally conceived financial statements. Historically, financial reporting has not (not been able to) reflect the demand for both potentially very useful and price-setting financial information (a typical example being internally generated intangible assets) and non-financial information (e.g. climate-related disclosures, sustainable development information, etc.). The concept of integrated reporting, which incorporates three core areas - economic, social and environmental, has already become established in the financial reporting (Dumay et al., 2016). The importance of this area of reporting is emphasized by Directive 2014/95/EU on the disclosure of non-financial information or area of integrated reporting. Integrated reporting adds to the traditionally conceived financial statements primarily the area of non-financial reporting, i.e., reporting of information that is not appropriate or possible to present in financial form. The regulation of financial reporting was the result of a long-standing demand from users of financial statements for additional information which was not captured in traditional financial statements. An area that was frequently analysed by researchers and authors at the turn of the millennium, but has not made its way into financial reporting from today's perspective, is the reporting of intellectual capital (Dumay, 2016). Regulatory requirements on disclosure of information regarding intellectual capital can be recognized in a number of jurisdictions (e.g. Sweden, Germany, Denmark). Following the demand for new information, the indicators provided by financial accounting, especially the accounting profit or loss as an indicator of the financial performance of the entity, have also been an area of discussion. Already in the 1970s, the idea that the accounting profit or loss showed only a narrow part of the success or failure of the entity was gaining prominence. Some of the critics of the accounting profit or loss indicator promoted the value added indicator instead, since it is also able to show the social effects of the accounting unit. (Burchell et al., 1985). The starting point of this paper is to define a specific mechanism for calculating value added from financial statements prepared according to IFRS, because the approach to the calculation of value added is not consistently and unambiguously defined according to the analysis in professional publications. The objective of this paper is to evaluate the suitability of using the value added as a tool for reporting intellectual capital. The VAIC and M-VAIC methodology is used for this purpose. At the turn of the millennium, Pulic (2000) used the concept of value added as a starting point for the development of a model for reporting intellectual capital - the Value Added Intellectual Coefficient (VAIC). At the same time, his contribution opened up again the space to discuss the advantages and disadvantages of value added as an indicator of entity performance (see Iazzolino and Laise, 2013; Ismail, 2006; Mulawarman, 2014; Ståhle et al, 2011). Since this time, model improvements have been proposed that have led to the indicator M-VAIC. To test the predictive power of the VAIC and M-VAIC indicator, two hypotheses were set based on the analysis already conducted. These hypotheses are tested on a sample of entities included in the DAX30 index using regression models to test the significance of the relationship between the VAIC indicator, the modified M-VAIC indicator and the performance of the entities. For the purpose of a more detailed analysis, a research question was also set to investigate the impact of the individual parts of the M-VAIC model. The paper builds on the research already conducted in the area of intellectual capital reporting using the VAIC and M-VAIC ratios, nevertheless provides an evaluation of the predictive power of both VAIC and M-VAIC on a single broad dataset in terms of number of entities and time periods. The data analysis is carried out over an 8-year period, which provides the possibility of comparability over time. The contribution of this paper is also the definition of the correct calculation of the value added, which is essential for the construction of the VAIC and M-VAIC indicator, and the subsequent testing of the indicators relevance on a sample of entities that have not been used for testing so far. These are the thirty largest accounting units listed on the Frankfurt Stock Exchange as of 31 December 2018. The influence of the business sector of the entities has also been included in the analysis which introduces a new factor for data evaluation for VAIC and M-VAIC models. Recent years have seen activity in financial reporting regulation focused on non-financial reporting. Examples include Integrated Reporting or Directive 2014/95/EU on the disclosure of non-financial and there can also be seen activities of the IASB. Paradoxically, VAIC and M-VAIC models are tools that are based entirely on traditional financial reporting and are constructed on financial values only. The conclusions of this paper may contribute to the debate on whether it is more appropriate to report intellectual capital information in monetary or non-monetary terms.

An overview of the literature and existing research

Disclosure of value added has been the subject of debate, especially in Western Europe and the United States. An article by Evraert and Riahi-Belkaoui (1998) summarises the evolution of value added disclosure across the United States, France, the UK and Germany. Haller and Stolowy (1998) focus on a comparison of regulatory requirements for value added disclosure in France and Germany. The authors conclude that, despite convergence in accounting regulation, there are significant differences between these countries. However, in none of those countries has the concept of value added in terms of financial statement disclosures gained much attention. On the other hand, the authors state that value added indicators are used in both countries by financial analysts having to extract the necessary information from the financial statements themselves, which is often complicated if not impossible. According to the authors, value added provides a more comprehensive view of the performance of accounting units, particularly in the area of intellectual capital and the social impact of the activities of accounting units. The importance of intellectual capital in accounting units has also been addressed by several authors, both in terms of intellectual capital management and intellectual capital disclosures. Pulic (2000) defined the Value Added Intellectual Coefficient (VAIC) model in his paper, and a modified version of this indicator was gradually developed, adding certain parts of intellectual capital that Pulic did not include in his model. The VAIC model is quite widely discussed. The main reason for the high interest is the possibility of calculating the indicator from publicly available data, which is a major advantage over other models (Balanced Scorecard, Intangible Assets Monitor, Wissensbilanz, etc.). The VAIC model also allows for comparison of the indicator among entities. There were analysed in particular the relationships between VAIC or M-VAIC and market value indicators, cost of capital or financial performance. Chen, Cheng and Hwang (2005) analysed the relationship between intellectual capital, value of entities and performance of entities using the VAIC model. Based on their research on entities listed on the Taiwan Stock Exchange, the authors concluded that those with higher intellectual capital efficiency have higher market value and achieve higher profitability. Zéghal and Maaloul (2010) analysed the relationship between intellectual capital and financial performance of entities using the VAIC model. The authors analysed 300 companies listed on the London Stock Exchange and concluded that a significant relationship exists only for entities operating in the high-tech industry. Ulum, Ghozali and Purwanto (2014) modified the VAIC model for their paper and extended it to include the relational capital factor. They define the relational capital as a component of intellectual capital that reflects the level of relations between an entity and its business partners (suppliers, customers, etc.). Based on empirical study the authors concluded that value added is strongly dependent on human, structural and physical capital, but failed to prove a significant dependence of value added on relational capital. Bryl and Truskolaski (2015) examined the effect of intellectual capital efficiency on the market value and financial performance of accounting units listed on the Warsaw Stock Exchange. The results of multiple linear regression confirmed the relationship between human capital and market value as well as the relationship between physical capital and financial performance, as measured by return on equity. A significant analysis was conducted by Sharma (2015), who tried to find a relationship between intellectual capital and market value of entities using a modified M-VAIC coefficient. Using multiple linear regression the author proved statistically significant dependence of market value of entities on human capital, physical capital, R&D and advertising costs. Bayraktaroglu, Calisir and Baskak (2019) focused on the application of modified M-VAIC coefficient in industrial enterprises in Turkey. The authors analysed the relationship between financial performance and the M-VAIC ratio and showed a statistically significant relationship between the market value of entites and human capital efficiency. Authors Xu and Liu (2020) applied the modified VAIC coefficient to accounting units in South Korea. Their quantitative research showed that the strongest relationship exists between financial performance and physical capital. However, there are also papers analysing the structure of the VAIC coefficient itself and questioning the concept of the model, mainly pointing out that the variables used do not correspond to the level of intellectual capital (Iazzolino and Laise, 2013; Ståhle et al., 2011). Ståhle, Ståhle and Aho analysed the validity of the VAIC coefficient as a tool for measuring intellectual capital and concluded that the VAIC coefficient measures the efficiency of the use of physical and human capital, but it cannot be considered as an indicator measuring intellectual capital. Iazzolino and Laise (2013) conducted a similar analysis and reported that the variables within the VAIC coefficient through which human and structural capital is captured have no relation to the definition of human and structural capital following the intellectual capital theory. For these reasons, according to the authors, the VAIC indicator cannot be considered as an indicator that effectively measures intellectual capital. The conclusions of these papers are reflected in the creation and analyses of a modified version of M-VAIC, which tries to eliminate the identified shortcomings (Ulum et al., 2014). In order to achieve the objective of this paper the relationships between the performance of entities and the VAIC coefficient, or the modified M-VAIC coefficient and its individual components are tested. Based on the research already conducted, the following hypotheses were established. The performance of entities is measured by the MV/BV ratio, which measures the market value (MV) of an entity against the book value (BV) of the entity. The second performance measurement variable is ROE (Robinson, 2020), which is a commonly used ratio for calculating return on equity. Two indicators are used for performance measurement because one is more of a market view of performance and the other characterize the accounting view (Nazari and Herremans, 2007). Hypotheses 1a and 1b test the basic two relationships that have been analysed in the research already conducted and refers to the original version of the Pulic´ model. These hypotheses assume that entities using their intellectual capital more efficiently have higher performance (Chen et al., 2005). These hypotheses were confirmed by Pulic in his paper (2000) and also by Chen (2005), but subsequent research have not clearly confirmed this conclusion (Xu and Liu, 2020; Zéghal and Maaloul, 2010).

Hypothesis 1a: *Entities with a higher VAIC have a higher MV/BV.*

Hypothesis 1b: *Entities with a higher VAIC have a higher ROE.*

The main criticism of the original version of the VAIC coefficient is directed at the absence of the influence of relational capital as a component of intellectual capital in the calculation, as well as the method of calculating the efficiency of structural capital (Iazzolino and Laise, 2013). The hypotheses are based on the assumption that R&D costs affect structural capital and increase the explanatory power of structural capital (Bayraktaroglu et al., 2019). The second difference of the modified version of M-VAIC is the inclusion of an additional variable in the form of advertising and marketing costs, which is a relational variable for an entity's investment in relational capital (Sharma, 2018). Thus, the hypotheses 2a and 2b are based on examining the relationship between the M-VAIC and MV/BV and ROE respectively.

Hypothesis 2a: *Entities with a higher modified M-VAIC have a higher MV/BV.*

Hypothesis 2b: *Entities with a higher modified M-VAIC have a higher ROE*.

The M-VAIC model consists of several indicators, so a research question was set, which addresses the issue of whether there is a significant relationship with any of these indicators, specifically the influence of human, structural or relational capital. The research question is based on the assumption that the disaggregated indicator will have a higher predictive power and the influence of its individual components will become apparent (Bryl and Truskolaski, 2015).

Research methodology

Data sample

The hypotheses are tested on the entities listed in the DAX30 stock index as of 31 December 2018, which consists of the 30 largest German companies traded on the Frankfurt Stock Exchange. From the perspective of the analysed entities, previous research within Europe has focused on entities listed on the UK and Polish stock exchanges, while German companies have not yet been the focus of in-depth analysis (Bayraktaroglu et al., 2019; Bryl and Truskolaski, 2015). This research builds on the analyses already conducted in the area of examining the explanatory power of the VAIC ratio, and in comparison with them, a contribution can be defined in a comprehensive analysis of the explanatory power of the VAIC ratio and the modified M-VAIC ratio on a sample of accounting units within the DAX30 index for eight consecutive years. The necessary information to perform the analyses were obtained by extraction from the consolidated financial statements and from available information on the market price of the entities' shares as of December 31, 2018. The categorization of the entities into different industries (traditional industry, high-tech industry and services) was performed according to the methodology of Zéghal and Maaloul (2010). Table I. provides an overview of the entities included in the analysis, including the categorization according to the industries in which they operate. The categorization is based on the methodology of the UK Department of Trade and Industry, which provides an approach to classify the 39 sectors of the economy into three categories to determine the level of value added of entities.

Table I.

The analysis covered the accounting units from 2011 to 2018 and the data was obtained using the Refinitiv Eikon database software. The basic sample consisted of 240 financial statements of the above 30 companies (30 companies for 8 accounting periods each). The following financial statements were excluded from the analysed financial statements according to the methodology of Zéghal and Maaloul (2010):

- containing negative equity,
- items with missing data (not disclosed in the financial statements or not included in the DAX30 index for analysed year),
- items showing extreme (outlying) values.

Table II. summarises the sample of financial statements analysed:

Table II.

To conduct the relevant analyses to test hypotheses 1 to 2 and, two dependent variables, two independent variables and three control variables were defined. The following table describes the variables:

Table III.

Lagrange multiplier test (Gourieroux, Holly and Monfort), F test for individual effects and Hausman test were performed to select the appropriate method for panel data evaluation for all regression models. The pooling OLS method was used as it has a higher predictive power than random and fixed effect methods according to the statistical tests performed. According to results of Breusch-Pagan test can be said that the heteroscedasticity is not statistically significant for analysed models.

Equations 1 and 2 analyse the relationship between the market-to-book value ratio (MV/BV) and return on equity (ROE) and VAIC. The VAIC is the dependant variable. MV/BV and ROE are the independent variables. The equations are used to test Hypotheses 1a and 1b.

$$MV/_{BV} = \alpha_0 + \alpha_1 * VAIC_{it} + \alpha_2 * SIZE_{it} + \alpha_3 * LEV_{it} + \alpha_4 * TECH_{it} + \alpha_5 * SERV_{it} + \varepsilon_{it} \quad (1)$$

$$ROE = \alpha_0 + \alpha_1 * VAIC_{it} + \alpha_2 * SIZE_{it} + \alpha_3 * LEV_{it} + \alpha_4 * TECH_{it} + \alpha_5 * SERV_{it} + \varepsilon_{it} \quad (2)$$

Equations 3 and 4 analyse the relationship between the market-to-book value ratio (MV/BV), or the return on equity (ROE), and the modified M-VAIC. The modified M-VAIC is the dependent variable. MV/BV and ROE are the independent variables. The equations are used to test Hypotheses 2a and 2b.

$$MV/_{BV} = \alpha_0 + \alpha_1 * MVAIC_{it} + \alpha_2 * SIZE_{it} + \alpha_3 * LEV_{it} + \alpha_4 * TECH_{it} + \alpha_5 * SERV_{it} + \varepsilon_{it} \quad (3)$$

$$ROE = \alpha_0 + \alpha_1 * MVAIC_{it} + \alpha_2 * SIZE_{it} + \alpha_3 * LEV_{it} + \alpha_4 * TECH_{it} + \alpha_5 * SERV_{it} + \varepsilon_{it} \quad (4)$$

Equations 5 and 6 are used to analyse the relationship between the market-to-book value ratio (MV/BV), alternatively the return on equity (ROE), and the individual components of the modified M-VAIC. CEE, HCE, SCME and RCE are the dependant variables. MV/BV and ROE are the independent variables. The equations are used to answer the research question, whether the individual parts of the M-VAIC model have predictive power.

$$MV/_{BV} = \alpha_0 + \alpha_1 * CCE_{it} + \alpha_2 * HCE_{it} + \alpha_3 * SCEM_{it} + \alpha_4 * RCE_{it} + \alpha_5 * SIZE + \alpha_7 * LEV + \alpha_8 * TECH + \alpha_9 * SERV + \varepsilon_i \quad (5)$$

$$ROE = \alpha_0 + \alpha_1 * CCE_{it} + \alpha_2 * HCE_{it} + \alpha_3 * SCEM_{it} + \alpha_4 * RCE_{it} + \alpha_5 * SIZE_{it} + \alpha_7 * LEV_{it} + \alpha_8 * TECH_{it} + \alpha_9 * SERV_{it} + \varepsilon_i \quad (6)$$

All the regression models above contain three control variables. The size of the entity (SIZE) is represented by total assets (Nimtrakoon, 2015; Xu and Liu, 2020). Entity debt (LEV) is accounted for by the ratio of total debts to total assets (Nimtrakoon, 2015; Xu and Liu, 2020). The last control variable takes into account the possible influence of the segments of the economy in which the entities operate (Zéghal and Maaloul, 2010).

Calculation of value added in financial accounting under IFRS

The basic approach to calculating value added is based on the difference between outputs and inputs (McLeay, 1983; Morley, 1979):

$$Value\ Added = output - input \quad (7)$$

The above calculation shows that the predictive power of the formula is similar to that of the accounting profit indicator, which measures revenues and expenses. In the basic formula for calculating value added the entity's outputs include, in addition to revenues, also in-house performance. According to IAS 1 (1.82a), revenue is a required disclosure item in the statement of comprehensive income. Following the structure of the statement of comprehensive income by type of expenses in accordance with IAS 1 (1.102), we include in the category of outputs the *items income and other income*, as well as *changes in inventories of finished goods and work in progress*. Paragraph 1.102 of IAS 1 also identifies the basic categories of inputs to be taken into account in the calculation of value added. These are *consumables and raw materials*, *depreciation and amortisation* and *other expenses*. *Employee benefit expenses* are not included among the inputs, as these are considered in the theory of value added to be a reward to stakeholders rather than a consumed input. From a financial accounting perspective, equation could therefore be defined as follows:

$$Value\ Added = (revenue\ and\ other\ income + changes\ in\ inventories\ of\ finished\ goods\ and\ work\ in\ progress) - (consumables\ and\ raw\ materials + depreciation\ and\ amortisation + other\ expenses) \quad (8)$$

The recommended structure of the statement of comprehensive income is approached in IAS 1 (1.102) in general, mainly because it sets out the concept of reporting information in the statement of comprehensive income, which must be applicable to all types of entities, as well as the possibility of using expense classification based on either their nature or function. During practical analysis of financial statements, it is therefore necessary to take into account the typology of entities.

There is also an approach for calculating 'net value added', where *depreciation and amortisation* is not treated as a consumed input as opposed to value added:

$$Net\ Value\ Added = (revenue\ and\ other\ income + changes\ in\ inventories\ of\ finished\ goods\ and\ work\ in\ progress) - (consumables\ and\ raw\ materials + other\ expenses) \quad (9)$$

As mentioned above, value added captures the distribution of success among stakeholders alongside the level of business success. To calculate value added from the perspective of capital distribution, the following formula can be established (McLeay, 1983; Morley, 1979):

$$Vaue\ added = reward\ of\ employees\ + reward\ of\ a\ government + reward\ of\ capital\ providers + retained\ (net)\ profit \quad (10)$$

The calculation of value added in this concept focuses on the distribution of value added among stakeholders, not on the structure of resources consumed and outputs provided. To achieve the objectives of this paper, it is essential to grasp the above approach to the calculation of value added and to define the calculation in relation to the items that financial accounting according to IFRS uses in its reporting. Calculation formula (11) in relation to financial accounting:

$$Value\ added = employee\ benefits + taxes + interest\ and\ other\ financial\ costs + dividends + retained\ (net)\ profit \quad (11)$$

Employee benefits are set by IAS 19 *Employee Benefits*, which regulates all forms of benefits provided by an entity to its employees, primarily wages, statutory contributions, non-monetary benefits and post-employment benefits. Share-based payments to employees should also be considered in accordance with IFRS 2 *Share-based Payment*. The second category is remuneration to the government in the form of taxes, where this is represented by a tax expense included in the statement of comprehensive income in accordance with IAS 1 (1.82(d)). Interest and other financial costs constitute reward for invested capital to its providers. According to IAS 1 (1.82(b)), an item *finance cost* (which represents this reward) is a mandatory part of the statement of comprehensive income. A significant item in terms of capital distribution is the reward of investors in the form of dividends declared. IAS 1 (1.107) requires disclosure of the amount of dividends paid to shareholders during the respective period in the notes or in the statement of changes in equity. The issue is that this item is not necessarily linked to performance in the respective disclosed financial year, as dividends are paid retrospectively from accounting profit and do not affect the statement of comprehensive income. However, if the decision to pay dividends for the period is made before the date the financial statements are authorised for issue, then information about the amount of dividends declared must be disclosed in the notes according to IAS 10 *Events after the reporting period* (10.13). This obligation is underlined also by IAS 1 (1.137). In this case, the amount is included in the calculation of the value added as reward of capital providers.

The VAIC model

The calculation of the VAIC ratio in original concept (Pulic, 2000) uses net value added (equation 9) for the calculation, which differs from value added by excluding depreciation and amortization from the inputs consumed. The objective of the coefficient is not to determine the value of intellectual capital in monetary terms, but to measure the efficiency of its use, similar to the efficiency of the use of physical capital. The higher the value of the VAIC coefficient, the higher the level of use of intellectual capital. According to Pulic, intellectual capital is divided into two categories – human capital and structural capital. It is further supplemented by the influence of physical capital in the calculation of the VAIC coefficient. Human capital is represented by the value of the employee expenses, including all benefits. In terms of IFRS accounting terminology, this is primarily employee benefits as defined in IAS 19. Structural capital was defined by Pulic as net value added less the value of human capital. On this basis, the inverse relationship between structural and human capital can be defined. Formula for calculating VAIC (Pulic, 2000):

$$VAIC = CEE + (HCE + SCE) \quad (12)$$

whereas,

CEE = $\frac{VA}{CE}$,

HCE = $\frac{VA}{HC}$,

SCE = $\frac{SC}{VA}$,

CEE = physical capital efficiency,

HCE = human capital efficiency,

SCE = structural capital efficiency,

VA = net value added,

CE = physical capital,

HC = human capital,

SC = structural capital.

The above formula shows that VAIC is the sum of the efficiency of the three types of capital.

Physical capital (CE) is measured by total assets minus intangible assets and recognised goodwill. The CEE ratio indicates the efficiency of the use of physical capital. Human capital (HC) is represented by the employee benefits as defined in IAS 19. Structural capital (SC) is considered to be the second component of intellectual capital alongside human capital. Pulic considers structural capital to be the residual share of intellectual capital after deduction of human capital, and this appears to be one of the problematic points of Pulic's approach. According to Pulic, structural capital is calculated as the difference between value added and the value of human capital. The SCE captures the efficiency of structural capital. Its value is inversely related to the efficiency of human capital (HCE). This approach to capturing structural capital is also the most criticised point of the VAIC indicator. Ståhle et al. (2011) are of the opinion that the calculation of structural capital according to Pulic has no relation to the actual level of structural capital of an entity. The value of structural capital efficiency (SCE) is directly derivable from the level of human capital efficiency (HCE) and thus it does not bring any new information as shown in formula 13:

$$SCE = 1 - \frac{1}{HCE} \quad (13)$$

The second point of criticism of Pulic's approach is the absence of relational capital in the VAIC, which is an important component of intellectual capital. Generally, intellectual capital is divided into human, structural and relational capital (Sharma, 2018). Pulic does not single out relational capital as a separate component in the VAIC ratio. Relational capital is defined by the level of relationships between the entity and its environment, i.e., relationships with customers, suppliers, the public, etc. Following the existing criticism, modified VAIC models have been developed, trying to eliminate these shortcomings and to extend the model to include an indicator of the effectiveness of relational capital. Most of the modifications have resulted in the inclusion of independent variables to capture structural and relational capital efficiency.

The modified M-VAIC model

In light of criticisms of the VAIC model, various modifications of the model have begun to appear in the literature (Bayraktaroglu et al., 2019; Nazari and Herremans, 2007; Ulum et al., 2014). In this paper, modifications in capturing both structural and relational capital are considered. Structural capital (SCM) in modified M-VAIC is characterized by the amount of R&D expenditures. The contribution is measured by the efficiency of these expenses. Relational capital (RC) is also measured by an independent variable, namely advertising and marketing expenses. The marketing and advertising expenses are divided by the value added to analyze what percentage of value added is created through marketing (Iazzolino and Laise, 2013; Nazari and Herremans, 2007; Sharma, 2018). The modified MVAIC formula is as follows:

$$MVAIC = CEE + HCE + SCME + RCE \tag{14}$$

whereas,

CEE = $\frac{VA}{CE}$,

HCE = $\frac{VA}{HC}$,

SCME = $\frac{SCM}{VA}$,

RCE = $\frac{RC}{VA}$,

CEE = physical capital efficiency

HCE = human capital Efficiency

SCME = structural capital efficiency modified

RCE = relational capital efficiency

VA = net value added

CE = physical capital

HC = human capital

SCM = structural capital measured as R&D expenses

RC = relationship capital measured as advertising and marketing expenses

Scientific papers analysing modified versions M-VAIC include an assessment according to which the modified version typically shows a more significant relationship with entity's performance than the tradition VAIC. However, it should be added that the inclusion of relational capital brings along the complication of identifying advertising and marketing costs from the financial statements because this cost category is not regularly included in the statement of comprehensive income.

Results and discussion

Table IV. shows the basic statistical indicators, namely the average, standard deviation, and minimum and maximum values of all variables. The average MV/BV is 2.3926, indicating that investors generally consider the market value of the sample of entities to be significantly higher than the book value of the entities (net assets). In other words, more than 58 % of the market value of the entities is not captured in the published financial statements. The return on equity

(ROE) varied over a wide range, as indicated by the minimum and maximum values together with the standard deviation. The value of M-VAIC shows a higher average value than the average value of VAIC, which is due to the consideration of relational capital as a separate component of intellectual capital. In terms of the individual components - CCE, HCE, SCME and RCE, it can be concluded that the highest efficiency is shown by relational capital (RCE) followed by human capital (HCE). This conclusion is in line with previous research concluding that the current economy is based on intellectual capital, in contrast to the previous era when value added was mainly created by the use of tangible assets (Pulic, 2000; Zéghal and Maaloul, 2010). The M-VAIC indicator (or even VAIC) can also be interpreted in such a way that on average, the entities generated €1.5929 of value added for each euro invested (€1.4510 for the VAIC indicator). The size of the accounting units shows a relatively high spread. The average debt ratio is 62.77 %, which indicates a generally higher proportion of external capital in terms of capital structure. The categorisation of the entities shows that 31.16 % of the entities belong to the traditional industry, 46.38 % of the entities are classified in the high-tech industry and the remaining 22.46 % are service oriented.

Table IV.

Table V. shows the correlation matrix of the dependent and independent variables. The correlation matrix shows a strong direct relationship between M-VAIC and CCE, HCE, RCE, which is logical since these are components of the indicator. Furthermore, a relatively strong negative relationship between ROE and HCE can be mentioned.

Table V.

Table VI. provides detailed information about average values through the view of sectors. The high-tech sector has the highest values for both indicators and the service sector the lowest. This result is inconsistent with the findings of Zéghal and Maaloul (2010), who found in a sample of UK accounting entities that the technology sector has the lowest VAIC value, and the traditional sector has the highest value. The authors themselves commented on this finding, stating that compared to continental Europe this is a surprising finding, which may be caused by the fact that UK accounting units are mainly focused on the traditional industry. It is noticeable that in a sectoral perspective, the M-VAIC indicator is higher than the VAIC indicator across all categories. The smallest difference between M-VAIC and VAIC is in the services sector, where the difference is 0.01. This minimal difference is due to the lower value of the efficiency of structural capital and relational capital compared to other sectors.

Table VI.

Pooling OLS was used to test the hypotheses. The first model tested the relationship between the MV/BV ratio and the traditional VAIC indicator, taking into account control variables. At the 0.05 level of significance, no statistically significant relationship between these variables could be demonstrated. In terms of the control variables, there was a significant influence of the sector in which the entities operate. The high-tech sector has a statistically significant positive effect on the MV/BV indicator. These findings are consistent with a number of analyses conducted that have failed to demonstrate a significant relationship between MV/BV and the VAIC indicator (Bryl and Truskolaski, 2015; Laing et al., 2010). The same model was used for the analysis of the relationship between VAIC and ROE. No statistically significant relationship was found between ROE and any of the explanatory variables. Compared to previous results, the coefficients of determination show that the model explains more MB/BV than ROE, for which the adjusted coefficient of determination is even negative. This finding is not consistent with the paper by Chen et al. (2005), which found a relationship between ROE and VAIC with an even higher coefficient of determination than the same model using MB/BV.

Table VII.

The analysis of the relationship between MB/BV (or ROE) and VAIC failed to show a statistically significant relationship. Hypothesis 1a - *Accounting units with higher VAIC show higher MB/BV and* hypothesis 1b - *Accounting units with higher VAIC show higher ROE* cannot be confirmed for either of the explained variables. Therefore, based on the analysis performed, the relationship between the VAIC and the performance of the entity measured from both market and accounting perspectives cannot be confirmed. The following regression model in Table VIII. analyses the relationship between the modified M-VAIC and the MV/BV indicator. The model confirmed a statistically significant positive relationship between M-VAIC and MV/BV at the 0.05 significance level, as well as a sector effect, with the high-tech sector positively influencing the MV/BV indicator. The adjusted coefficient of determination shows a value of 0.1757, thus it can be argued that the model explains 17.57% of the MV/BV value. The above finding confirms the conclusion of Bayraktaroglu et al. (2019), who found a higher predictive power of the modified M-VAIC indicator compared to the conventional VAIC model. Similarly, it confirms the conclusion of Xu and Liu (2020) using regression analysis that the modified M-VAIC model more relevantly explains both MB/MV and ROE. Hypothesis 2a - *Entities with a higher modified VAIC indicator show a higher value of MV/BV indicator* was confirmed based on the analysis performed, where the positive relationship is statistically significant. The regression model in Table VIII. also confirmed a statistically significant relationship between ROE and the modified M-VAIC. The model shows a negative relationship, with the M-VAIC decreasing the ROE. Compared to the model with the explained variable MV/BV, this model shows an adjusted coefficient of determination of 0.03709 compared to 0.1757. Hypothesis 2b - *Accounting units with a higher modified VAIC indicator have a higher value of ROE* was rejected as the analysis revealed a statistically significant negative relationship. In comparison with the base VAIC ratio, the effect of relational capital can be highlighted, for the absence of which the traditional model has been criticised (Iazzolino and Laise, 2013; Ståhle et al., 2011). It can be said that the modified M-VAIC model better explains the performance of an entity from a market and accounting perspective.

Table VIII.

The last two regression models were constructed to find additional information and to answer the research question about the structure of the modified M-VAIC model. Table IX. presents the results of the regression analysis to test the relationship between each part of the modified M-VAIC and MV/BV and ROE, respectively. The results of the model show a statistically significant relationship between each part of intellectual capital - HCE, SCME and RCE and MV/BV. Human capital efficiency (HCE) shows a negative relationship. In contrast, the efficiency of structural capital (SCME) and relational capital (RCE) have a positive relationship. There was also a significant relationship between the control variables – size (negative relationship), debt (positive relationship) and categorization into high-tech sector (positive relationship). The above model shows an adjusted coefficient of determination of 0.3036, thus explaining almost one-third of the MV/BV indicator, the highest among all models. The significant relationship has not been confirmed only for physical capital efficiency. These results are consistent with those obtained in previous research. Using a sample of 500 firms, Sharma (2018) found a significant negative relationship between human capital and MV/BV indicator and a positive relationship for the other components. Research by Bryl and Truskolaski (2015), Bayraktaroglu et al. (2019) and Zéghal and Maaloul(2010) confirmed a positive relationship among all components and performance indicators. Table IX. also presents the results of a regression model that tests the relationship between the individual components of the modified M-VAIC and ROE. In this model, a statistically significant relationship was found between the efficiency of physical capital (CCE), human capital (HCE) and the impact of the high-tech sector. For these significant dependant variables, only CCE showed a positive relationship with ROE, while in contrast, both HCE and the high-tech sector affect ROE negatively.

Table IX.

Conclusion

Value added reporting is not a new area in financial accounting. However, it has not been yet widely established in general practice. Many academic papers deal with the construction of the value added indicator and its use for evaluating and predicting the performance of accounting units. One of these areas is the use of value added to evaluate the intellectual capital of an accounting unit in the VAIC model (Pulic, 2000) and its modified versions M-VAIC. In the reviewed literature and research articles, inconsistencies can be found in the calculation of value added from the data disclosed in financial statements Therefore, the first objective of this paper was to analyse the possibilities of obtaining value added indicators from financial statements prepared in accordance with IFRS, following the theoretical definition of value added. The value added was then used to calculate the VAIC ratio and the modified M-VAIC ratio, as the modified M-VAIC model takes into account the shortcomings of the classical VAIC model (Iazzolino and Laise, 2013; Zéghal and Maaloul, 2010). Building on the research already conducted, a significant relationship between MV/BV and the modified M-VAIC and most of its components has been demonstrated. It was not possible to confirm the association between the VAIC indicator and MV/BV, confirming the limited predictive power of this indicator. In terms of ROE, the only relationship was again confirmed with the modified M-VAIC indicator. All these models showed a lower predictive power for the explained variable ROE compared to MV/BV. This paper expanded the existing research with an analysis of a sample of accounting entities from Germany, which has not been in a broader sense conducted so far. Most of the research confirmed the higher predictive power of the modified M-VAIC indicator compared to the classical VAIC model. Nowadays, a significant development of non-financial reporting can be observed, both from the perspective of the European Union and the IASB. Directive 2014/95/EU on the disclosure of non-financial and diversity-related information or the direction of integrated reporting can be set as examples of this trend. The results of the analysis in this paper show the relationship between M-VAIC and performance indicators. The M-VAIC indicator could be used for a one-dimensional indicator on intellectual capital that can be compared cross-sectoral and cross-company, specifically in the area of non-financial reporting by companies. Future research could focus on analysing M-VAIC and VAIC for entities from different jurisdictions and time periods in relation to economic cycles. Space should also be given to the analysis of the construction of the VAIC model itself, as it has not yet been sufficiently demonstrated that it captures intellectual capital in its entirety. Both the VAIC and M-VAIC coefficients use univariate variables obtained from accounting reports to determine the level of each component of intellectual capital - human, structural and relational. While this procedure allows for a calculation based on publicly available information, it may not reflect the level of intellectual capital, which is theoretically defined much more broadly and often described in ways that cannot be quantified. As a supporting example, human capital has been found to have a negative impact on both MV/BV and ROE. That contradicts the theory of intellectual capital, which presents human capital as one of the fundamental pillars of value added. However, for this analysis, internal information from entities would be needed to characterise the level of intellectual capital in relation to intellectual capital theory.

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Tables

Accounting unit	Sector of the economy	Industry categories
ADIDAS AG	Textile, clothing, and leather industry	Traditional industry
ALLIANZ SE	Finance and insurance	Services
BASF SE	Chemical, pharmaceutical and refining industries	High-tech industry
BAYER AG	Chemical, pharmaceutical and refining industries	High-tech industry
BAYER. MOTOREN WERKE	Manufacture of transport equipment	Traditional industry
BEIERSDORF AG	Chemical, pharmaceutical and refining industries	High-tech industry
CONTINENTAL AG	Manufacture of transport equipment	Traditional industry
COVESTRO AG	Chemical, pharmaceutical and refining industries	High-tech industry
DAIMLER AG	Manufacture of transport equipment	Traditional industry
DEUTSCHE BANK AG	Money and insurance	Services
DEUTSCHE BOERSE AG	Money and insurance	Services
DEUTSCHE LUFTHANSA	Transport, storage and postal activities	Services
DEUTSCHE POST AG	Transport, storage and postal activities	Services
DEUTSCHE TELEKOM AG	Telecommunications and information technology	High-tech industry
E.ON SE	Production of electricity, gas and water	Services
FRESENIUS MEDICAL CA	Chemical, pharmaceutical and refining industries	High-tech industry
FRESENIUS SE	Chemical, pharmaceutical and refining industries	High-tech industry
HEIDELBERGCEMENT AG	Construction	Traditional industry
HENKEL AG AND	Chemical, pharmaceutical and refining industries	High-tech industry
INFINEON TECHNOLOGY	Telecommunications and information technology	High-tech industry
LINDE PLC	Chemical, pharmaceutical and refining industries	High-tech industry
MERCK KGAA	Chemical, pharmaceutical and refining industries	High-tech industry
MUNCHENER RUCKVER	Money and insurance	Services
RWE AG	Production of electricity, gas and water	Services
SAP SE	Telecommunication and information technology	High-tech industry
SIEMENS AG	Manufacture of machinery and equipment	Traditional industry
THYSSENKRUPP AG	Manufacture of machinery and equipment	Traditional industry
VOLKSWAGEN AG	Manufacture of transport equipment	Traditional industry
VONOVIA SE	Money and insurance	Services
WIRECARD AG	Telecommunication and information technology	High-tech industry

Table I.: Structure of accounting units included in the analysis. Source: Own computation.

Basic sample	240
Items with negative equity	1
Items with incomplete data	97
Items with extreme values	4
Sample analysed	138

Table II.: Analysed sample of accounting units. Source: Own computation.

Variable	Variable type	Calculation	Characteristics
MV/BV	Dependent	(Market value per share * number of shares) / Equity (Robinson, 2020)	The indicator reflects the market performance of the entity.
ROE	Dependent	Profit after tax / Equity (Robinson, 2020)	This indicator measures the accounting performance of an entity.
VAIC	Independent	See chapter The VAIC model	Overall efficiency of intellectual capital
MVAIC	Independent	See chapter The modified M-VAIC model	Overall efficiency of intellectual capital
SIZE	Control	Total assets	Size of the accounting unit
LEV	Control	Total liabilities / Total assets	Indebtedness of the entity
SEC	Control	TRAD, TECH, SERV (dummy variables)	Industry categories - traditional industry, high-tech industry and services

Table III.: Summary of variables. Source: Own computation.

Variable	Min.	Max.	Average	Standard deviation
MV/BV	0.4873	5.2999	2.3926	1.1753
ROE	- 132.7800	265.9200	14.6300	28.3501
VAIC	1.0070	2.3390	1.4510	0.2585
MVAIC	0.5688	2.7633	1.5929	0.5440
CCE	0.0074	1.3390	0.4513	0.2585
HCE	0.2066	1.0832	0.4639	0.1363
SCME	0.0002	0.2391	0.0751	0.0613
RCE	0.848	1.7572	0.6026	0.3863
SIZE	1,425,085.0000	301,729,000.0000	67,319,008.0000	61,865,043.3100
LEV	0.3211	0.9855	0.6277	0.1640
TRAD	0.0000	1.0000	0.3116	0.4631
TECH	0.0000	1.0000	0.4638	0.4987
SERV	0.0000	1.0000	0.2246	0.4173

Table IV.: Basic statistical variables. Source: Own computation.

	MV/BV	ROE	CCE	HCE	SCE (RD)	RCE	VAIC	MVAIC
MV/BV	1.00	0.24	0.22	-0.04	0.29	0.24	0.22	0.3
ROE	0.24	1.00	0.05	-0.38	0.04	-0.2	0.05	-0.2
CCE	0.22	0.05	1.00	0.41	0.28	-0.04	0.52	0.58
HCE	-0.04	-0.38	0.41	1.00	0.01	0.03	0.41	0.66
SCME	0.29	0.04	0.28	0.01	1.00	-0.12	0.28	0.16
RCE	0.24	-0.20	-0.04	0.03	-0.12	1.00	-0.04	0.76
VAIC	0.22	0.05	0.52	0.41	0.28	-0.04	1.00	0.58
MVAIC	0.30	-0.20	0.58	0.66	0.16	0.76	0.58	1.00

Table V.: Correlation matrix of dependent and independent variables. Source: Own computation.

Sector	MV/BV	ROE	CCE	HCE	SCME	RCE	VAIC	MVAIC
TRADITIONAL INDUSTRY (TRAD)	1.92	12.49	0.40	0.48	0.08	0.63	1.40	1.60
HIGH-TECH INDUSTRY (TECH)	2.89	14.87	0.61	0.46	0.09	0.61	1.61	1.78
SERVICES (SERV)	2.02	17.11	0.20	0.44	0.03	0.54	1.20	1.21

Table VI.: Average values for the sectors in the analysed sample. Source: Own computation

MVBV = VAIC + SIZE + LEV + TECH + SERV				
Residuals:				
Min	1Q	Median	3Q	Max
-1.6559	-0.8266	-0.1778	0.6888	3.1666
Coefficients	Estimate	Std Error	t value	Pr (>|t|)
(Intercept)	2.110e+00	9.616e-01	2.194	0.029964*
VAIC	-2.127e-01	4.765e-01	-0.446	0.655988
SIZE	-4.149e-09	2.228e-09	-1.863	0.064753.
LEV	7.093e-01	1.183e+00	0.599	0.549874
TECH	9.246e-01	2.522e-01	3.666	0.000355***
SERV	-1.543e-02	3.528e-01	-0.044	0.965180
Signif. Codes:	0 ***	0.001 **	0.01 *	0.05 .
Residual standard error: 1.087 on 132 degrees of freedom				
Multiple R-squared:	0.1821	Adjusted R-squared:	0.1511	
F-statistic:	5.876 on 5 and 132 DF	p-value:	6.179e-05	
ROE = VAIC + SIZE + LEV + TECH + SERV				
Residuals:				
Min	1Q	Median	3Q	Max
-146.865	-4.710	0.951	5.502	246.994
Coefficients	Estimate	Std Error	t value	Pr (>|t|)
(Intercept)	9.661e-01	2.549e+01	0.038	0.970
VAIC	1.272e+01	1.263e+01	1.007	0.316
SIZE	2.880e-08	5.904e-08	0.488	0.627
LEV	-1.367e+01	3.136e+01	-0.436	0.664
TECH	-6.303e-01	6.684e+00	-0.094	0.925
SERV	9.546e+00	9.351e+00	1.021	0.309
Signif. Codes:	0 ***	0.001 **	0.01 *	0.05
Residual standard error:28.81 on 132 degress of freedom				
Multiple R-squared:	0.0124	Adjusted R-squared:	-0.02501	
F-statistic:	0.3314 on 5 and 132 DF	p-value:	0.8933	

Table VII.: Pooling OLS of MVBV or ROE and VAIC. Source: Own computation.

MVBV = MVAIC + SIZE + LEV + TECH + SERV				
Residuals:				
Min	1Q	Median	3Q	Max
-1.7419	-0.8090	-0.1535	0.6616	2.9170
Coefficients	Estimate	Std Error	t value	Pr (>|t|)
(Intercept)	6.133e-01	8.801e-01	0.697	0.48712
MVAIC	4.468e-01	2.194e-01	2.037	0.04370*
SIZE	-2.618e-09	2.238e-09	-1.169	0.24431
LEV	1.272e+00	1.199e+00	1.060	0.29089
TECH	9.325e-01	2.364e-01	3.944	0.00013***
SERV	5.859e-02	3.356e-01	0.175	0.86166
Signif. Codes:	0 ***	0.001 **	0.01 *	0.05
Residual standard error: 1.071 on 132 degrees of freedom				
Multiple R-squared:	0.2058	Adjusted R-squared:	0.1757	
F-statistic:	6.84 on 5 and 132 DF	p-value:	1.05e-05	
ROE = MVAIC + SIZE + LEV + TECH + SERV				
Residuals:				
Min	1Q	Median	3Q	Max
-121.954	-4.996	0.870	8.066	240,440
Coefficients	Estimate	Std Error	t value	Pr (>|t|)
(Intercept)	6.652e+01	2.294e+01	2.899	0,00438**
MVAIC	-1.771e+01	5.719e+00	-3.097	0,00239**
SIZE	-3.625e-08	5.835e-08	-0.621	0,53556
LEV	-3.573e+01	3.126e+01	-1.143	0,25512
TECH	-2.161e-01	6.164e+00	-0.035	0,97209
SERV	5.771e+00	8.749e+00	0.660	0.51066
Signif. Codes:	0 ***	0.001 **	0.01 *	0.05 .
Residual standard error: 27.92 on 132 degrees of freedom				
Multiple R-squared:	0.07223	Adjusted R-squared:	0.03709	
F-statistic:	2.055 on 5 and 132 DF	p-value:	0.07503	

Table VIII.: Pooling OLS of MVBV or ROE and M-VAIC Source: Own computation.

MVBV = CCE + HCE + SCME + RCE + SIZE + LEV + TECH + SERV				
Residuals:				
Min	1Q	Median	3Q	Max
-2.5161	-0.7035	-0.1859	0.6719	2,6503
Coefficients	Estimate	Std Error	t value	Pr (>|t|)
(Intercept)	3.054e-01	8.141-01	0.375	0,708206
CCE	5.848e-01	5.163e-01	1.133	0,259434
HCE	-2.052e+00	7.933e-01	-2.587	0,010790*
SCME	6.280e+00	1.539e+00	4.082	7,78e-05***
RCE	1.109e+00	2.752e-01	4.029	9,53e-05***
SIZE	-5.480e-09	2.130e-09	-2.573	0,011218*
LEV	2.503e+00	1.141e+00	2.193	0,030116*
TECH	8.571e-01	2.410e-01	3.556	0,000527***
SERV	.585e-01	3.281e-01	0.483	0,629919
Signif. Codes:	0 ***	0.001 **	0.01 *	0,05 .
Residual standard error: 0.9844 on 129 degrees of freedom				
Multiple R-squared:	0.3442	Adjusted R-squared:	0.3036	
F-statistic:	8.464 on 8 and 129 DF	p-value:	3.309e-09	
ROE = CCE + HCE + SCME + RCE + SIZE + LEV + TECH + SERV				
Residuals:				
Min	1Q	Median	3Q	Max
-72.769	-9.751	-1.187	6.558	221,699
Coefficients	Estimate	Std Error	t value	Pr (>|t|)
(Intercept)	6.903e+01	2.085e+01	3.311	0,0012**
CCE	4.380e+01	1.322e+01	3.313	0,0012**
HCE	-1.203e+02	2.031e+01	-5.923	2,7e-08***
SCME	1.602e+01	3.940e+01	0.407	0,6849
RCE	-4.611e+00	7.048e+00	-0.654	0,5141
SIZE	-7.049e-08	5.454e-08	-1.292	0,1985
LEV	-1.382e+01	2.923e+01	-0.473	0,6371
TECH	1.354e+01	6.172e+00	-2.194	0,0300*
SERV	1.304e+01	8.401e+00	1.552	0,1232
Signif. Codes:	0 ***	0.001 **	0.01 *	0,05 .
Residual standard error: 25.21 on 129 degrees of freedom				
Multiple R-squared:	0.261	Adjusted R-squared:	0.2151	
F-statistic:	5.694 on 8 and 129 DF	p-value:	3.359e-06	

Table IX.: Pooling OLS of MVBV or ROE and CCE, HCE, SCME, RCE. Source: Own computation.