UNIVERSITY OF GOTHENBURG
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Impact of Intellectual Capital on Firm Performance and Market to Book Value

An analysis of the extended VAIC™ model on Swedish listed firms within the healthcare sector

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Abstract

The purpose of this thesis is to research whether IC and the individual components of IC in firms, namely the relational capital, structural capital, innovation capital and human capital, contribute to an increase in financial performance and positive market reaction for listed Swedish healthcare firms listed in Stockholm OMX30 with a time-frame of 10 years from 2009 to 2018. An extended VAIC^{TM} model developed from the original VAIC^{TM} model proposed by Pulic is used as a proxy for efficient IC usage and a fixed effects regression is performed on the explanatory variables representing firm performance and market perception. Firm performance is divided by ROA and ROE representing financial performance, and ATO representing productivity. Market perception is measured by market to book value. The analysis shows varying relationships between IC and firm performance and market perception. The result suggests no significant relationship for the overall IC, whereas some of the individual components of IC were shown to improve productivity and market perception, potentially being valuable in internal decision making.

Keywords: Intellectual capital, VAIC^{TM}, Firm performance, Market to book value, Swedish healthcare sector.

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Sincerely,
Linus Åhman & Sang Hoon Sohn
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1 Introduction

The competitive environment is becoming more intense and companies have to invest and create value from knowledge-based products in order to keep up with the emerging business environment, which had caused a shift of focus from manufacturing and industrial productions with tangible assets to increasing focus on the importance of building IC (Dean and Kretschmer, 2007). In the technology-driven and knowledge-driven economy of today, different authors (Lev and Daum, 2004; Gu and Lev, 2011; Zeghal and Maaloul, 2011; Rehnberg, 2012) argue that intangible assets have been referred to as being major drivers. Rhenberg (2012) furthermore highlights that investments in IT, human resources, R&D and marketing have all been crucial to firms' successes. The knowledge-based perspective has attracted significant interest in the last decades (Campisi and Costa, 2008; Petty and Guthrie, 2000), and many organizations have become more aware of the value within intangible assets such as brand value and wealth within intellectual property, and of how knowledge can be converted into profit (Harrison and Sullivan, 2000). Stewart (1997) argues that intellectual resources such as knowledge, expertise and information act as wealth creating tools and that Intellectual Capital (IC) is the new wealth of organizations, which is further agreed with by Nahapiet (2009), stating that organizations nowadays view IC as the foundation of their success.

IC and knowledge-based resources are recognized to be important sources in gaining sustainable competitive advantages (Pulic, 1998, 2000, 2008), and different academic fields have suggested a significant relationship between firm performance and IC (Grindley and Teece, 1997; Menor *et al*., 2007; Youndt *et al.*, 2004; Roos *et al.*, 2001). Serenko and Bontis (2013) further found that IC is one of the basic factors determining firm performance. As early as in the 1980s, the mystery behind the high market to book value ratios were raised (Sullivan, 1998), which is also examined by Sveiby (1997), highlighting Microsoft's stock trading at market value ten times higher than its book value in 1985, explaining the difference with intangible assets, which was later defined as Intellectual Capital by Sullivan (1998). For companies listed on the OMX Stockholm 30 Index, the price to book ratio was 2.37 (Bloomberg, 20-01-08), further highlighting the continuous importance of intangible assets, how knowledge can be converted into profit and how the concept of IC has become the foundation of firms' success. Therefore, the set of non-financial information and non-physical resources that are not reflected in the financial statements may have significant influence the company's financial performance and an important role in understanding deeper into the market valuation of companies, as well as giving detailed insight into the future potential of firms' efficient use of IC in profit generation to gain competitive advantage, further contributing to a better understanding of the impact of the different aspects within IC on value creation.

1.1 Problem Formulation

1.1.1 Difficulty in IC management

IC management and measurement can be beneficial in many areas such as in achieving strategic goals, training programs for employees and planning R&D in firms (Chen *et al*., 2004) and therefore the importance and need to measure IC has been rising within organizations that wish to manage their knowledge (Bontis, 1996), along with the focus on trying to understand how IC improves firms' financial performances. The inherent problem in IC management is that it is difficult to measure a firm's IC with financial tools, since those measurements cannot put a precise number on intangible assets such as knowledge of employees (Marr, 2007). Furthermore, the unavailability of data and the subjective nature of IC makes it difficult to objectively compare between firms and their progress over years, and therefore for management to efficiently manage. The increased awareness of IC has contributed in further highlighting the management and measurement difficulties of IC (Kim *et al*., 2009) compared to physical assets, as it is difficult to manage what you cannot measure. Andreou *et al.* (2007) further build on this problem, stating that IC is considered the most critical resource of enterprises of today, but most firms cannot clearly define what constitutes IC.

Earlier understanding of IC was that "when a company is bought for more than its book value… that premium usually consists of intellectual assets" (Stewart, 1997), and market value minus book value is widely used to account for IC. However, Stewart also says in the same book that a firm does not know the "replacement costs of employee's skills, much less whether they are appreciating or depreciating", suggesting that the market value may provide a quantification but not help firms in analyzing the state of their IC, their efficient usage of it and how they provide value. Market value of a firm is calculated from the stock price which can vary greatly from day to day depending on the market's expectation of the firm's value and other economic factors unrelated to the firm's assets (Luthy, 1998), with many of such values being over or undervalued. Therefore, the market value is not able to provide the necessary insight into the firms' actual IC performances that can be used as comparisons to other firms. In addition, the book values in the equation represent historical values of the firm's assets which are or may not be accurate.

Enterprises are in need of insightful knowledge of IC and its efficient usage realistically to enable management to infer the firm's future potential and be used as a performance benchmark for the firm and other related parties, rather than solely knowing the additional price traders are willing to expend for their firm's stocks, which in turn may impact firm performance and value creation process from IC. Examining this impact may enable a more detailed understanding, which can be a better guide for strategic policies than the traditional financial measurements (Chen *et al*., 2004).

1.1.2 Varying outcomes in different settings

Following the understanding of the role of IC on firms, it might seem logical that a better and more efficient IC management will lead to a better firm performance and a higher market valuation. However, as suggested by Eisenhardt and Martin (2000), the direct relationship between IC and firm performance should be carefully interpreted, as the business environment can vary and be unpredictable, and also simply owning knowledge resources may not guarantee competitive advantages. For example, Firer and Williams (2003) studied the relationship for firms in South Africa within IC intensive industries, where they claim that the "understanding and development of IC concepts in emerging economies is still very much in its infancy" and their empirical study found no significant association between IC efficiency and firm performance and market value, with the speculation that the South African market puts a much larger emphasis in firms' tangible assets and views firms enhancing their IC as a negative trait of focusing less on the more 'important' assets. As for firm performance, they suggest the difficulty in capturing the precise effect of IC due to firm performance constituting of many different dimensions. There have been many other studies with similar findings mostly in countries where IC development is still at an early stage (Kamath, 2008; Puntillo, 2009; Maditinos *et al.*, 2011).

It can be inferred from the results of these studies explain that the non-association of IC and firm performance as well as market valuation can differ in different contexts, and scholars suggest that the effect of IC on firms can be country and industry-specific (Bontis, 1998; Denicolai *et al.*, 2015; Kamukama *et al.*, 2010; Nimtrakoon, 2015; Puntillo, 2009; Tseng *et al.*, 2013). Countries and industries differ in terms of the level of development and have different cultures that can for example alter how much emphasis is placed on IC for firm value and how they are perceived. Due to these characteristics, this thesis is able to provide additional insight into the relationship in question in a new context, while adding to the existing literature in the subject of IC by showing its various impact on firms.

1.2 IC context in Swedish healthcare sector

As different markets and countries influence the relationship between IC and firm performance, studies in this topic conducted in diverse contexts have shown varying results. Bounfour (2003) conducted a study on companies within 14 countries in the EU of measuring the countries' IC performance by using the intellectual capital dynamic value approach, in which Sweden was found to have the highest overall IC performance index along with Finland and the Netherlands (Vandermaele *et al.*, 2005) due to Swedish organizations having understood the essential issue of development and management of IC. Furthermore, as noted by Vandemaele *et al.* (2005) and Saleh *et al.* (2010), Swedish firms, compared to other European countries', are well advanced in reporting IC such as frequent disclosures, and Sweden was also found to be on top rankings in terms of IC in multiple categories in Lin and Edvinsson's (2008) empirical study within the Nordic countries. In addition, intangible assets are a vital part of the healthcare sector, with most focusing on operating licenses and permits, noncompetition agreements, supplier purchase agreements, patents, medical software and goodwill, to name a few (Jelonek and Halilovic, 2016). With these aspects of the context, a hypothesis on the relationship can be developed and examined.

1.3 Aim of the study

Due to the inherent difficulties in measuring and managing IC and the rising importance of it, it is ever more important to understand the relationship between IC and what it contributes to in terms of performance and value creation. Having this understanding can aid managers in decision making. In addition, since each country and market environments have different developments and perceptions of IC, the relationship can also vary depending on the context and a closer inspection is helpful for maximizing benefit from IC performance management. Therefore, the purpose of the study is to empirically test IC's influence on financial performance and market values of Swedish firms listed on OMX STOCKHOLM 30 (OMX30) by using efficient IC usage as a proxy for IC using an extended VAIC^{TM} model. The relationship has not previously been studied in Sweden, a country that has a high understanding and development of the concept of IC, and it is a contrasting setting to previous literatures' countries. In addition, we have chosen to examine the healthcare sector due to the IC intensive nature of the industry, especially the knowledge-based intangible assets (Demmou *et al.*, 2019). The study will then analyze whether Swedish firms are efficiently utilizing their IC and whether it is impacting firm performance, in addition to the market's perception of firms' IC.

2 Literature Review

2.1 Theory

2.1.1 Contingency Theory

Within science the abstract definition of a contingency says that the effect of one variable depends upon some third variable. A contingency can be explained as any variable that has an impact on the organization and changes its circumstances. The foundation of the contingency theory paradigm is the fit-performance relationship, where organizations gain effectiveness by fitting and adapting the organization to its contingencies (Burns and Stalker, 1961). The structure of organizations should therefore be optimally fit to the aspects that reflect the context of organizations, such as environment, organizational size and organizational strategy (Burns and stalker, 1961; Child, 1975; Chandler; 1962). An organization that has a fit between its characteristics and its contingencies would gain a higher performance, therefore there is a constant will of organizations to try to adapt to the changing environment and contingencies in order to prevent a misfit that will lead to lower performance. The theory highlights the need for constant adoption by organizations, and that there is "No best way" to organize, as the contingencies constantly change. Burns and Stalker (1961) explain that contingencies lead to change in organizational structure, when the contingencies later change the old structure adopted by companies are out of fit which will lower performance, organizations therefore adapt once again to the new setting and contingencies to restore its performance. Technology, digitalisation and innovation has increased the phase of this change and companies today have to be flexible and fast to adapt to the changing contingencies. Further, IC can be perceived as a firm characteristic, which is affected by the context and changing contingencies stemming from the operational environment (Huang et al, 2010), contingency theory may therefore emphasize and explain the development and increased awareness of IC within organizations of today. As further presented by Huang et al (2010), the authors found by examining the contingency variables business strategy and technological advancement of customer service, had a positive significant impact on availability of internal IC information in Malaysian firms.

2.1.2 Resource-Based Theory

Resource-based view of the firm is strategic planning that suggests that creating and maintaining strategic resources is the way for firms to build a sustainable competitive advantage (Peteraf, 1993; Wernerfelt, 1984). Examples of the strategic resources that provide competitive advantage to firms are ones that are valuable, rare, difficult to imitate or difficult to substitute (Barney, 1991). According to these characteristics, knowledge, and intellectual capital, fits to the attributes to be considered a resource of a firm that can provide competitive advantage (Spender & Grant, 1996). From this resource-based perspective where knowledge is a resource that provides competitive advantage, a firm’s knowledge can foster firm performance and competitive advantage in a variety of ways. Firms may invest in research and development to create intellectual capital that can provide value when integrated into the firm’s value creation process, and studies have shown a positive relationship between R&D expense and earnings (Ciftci & Cready, 2011; Lev & Sougiannis, 1996). Hiring employees with desirable knowledge and expertise enhances a firm’s overall knowledge resources, which in turn can bring success to firms (Hall, 1992; Madsen et al., 2003). In addition, a firm’s knowledge and IC in customer relations can contribute significantly in improving production, sales processes and marketing and sales strategies (Sydler et al., 2014). Having this knowledge as a resource allows firms to build an on-going relationship with customers and have better connectivity with them (Vargo and Lusch, 2004).

2.2 Definition and concepts of IC

Business enterprises of today in the knowledge era have, according to Andreou et al. (2007), the need to become “intelligent” in order to understand and adapt to its environment, and to have the adequate ability to value its intangible resources. In addition, IC is the most critical resource, but most firms cannot clearly define what constitutes IC (Andreou *et al.,* 2007). They argue that businesses require the tool to scrutinize and codify its business functions in order to be able to model the activities that result in performance of the enterprise. Different definitions have been developed in order to create an understanding of what IC is and what IC constitutes, due to the nature of IC and the difficulties in identification. Today, there are many different explanations of IC, however many are similar and scholars seem to agree on the same points. Some authors define IC as the difference between a firm's book and market value (Edvinsson and Malone, 1997; Kok, 2007; Lynn, 1998), whereas others define it as knowledge that can be converted into value or profits (Bontis, 1998; Hunter *et al., 2005*; Sullivan, 2000). Youndt *et al.* (2004) broadly defines IC as "knowledge resources that organizations utilize for competitive advantage", with knowledge becoming a more important source of competitive advantage than tangible assets. IC is also characterized as 'hidden values' that are not appropriately represented by traditional financial observations (Fincham and Roslender, 2003). In general, IC refers to "intangible assets or business factors of the company, which have a significant impact on its performance and overall business success, although they are not explicitly listed in the balance sheet" (Mondal and Ghosh, 2012).

Although the definitions vary, three components of IC are popular and in general well recognized by scholars, namely human capital (HC), structural capital (SC) and relational capital (RC). HC refers to all the knowledge, skills and competencies, to name a few, of the employees that "foster performances customers are willing to pay for" (Bornemann *et al.*, 1999). SC is what remains when "people leave to go home for the night" (Fincham and Roslender, 2003), the capital that remains in the structure of the firm such as databases, internal systems, organizational culture and even innovation capital, of which intellectual property is a part of. Different scholars focused on different components, with Edvisson and Malone (1997) studying the HC and SC components of IC, and Bontis (1996) introducing RC as another component. RC was explained as the "expanded version of customer capital that includes the value of all relationships including those of customers" (Youndt *et al.*, 2004). A visual breakdown of the different components of IC are shown in Figure 1 below. However, IC is not simply the sum of the three components, since it is up to the individual firms to allocate these resources and capitals appropriately to create value (Mondal and Ghosh, 2012).

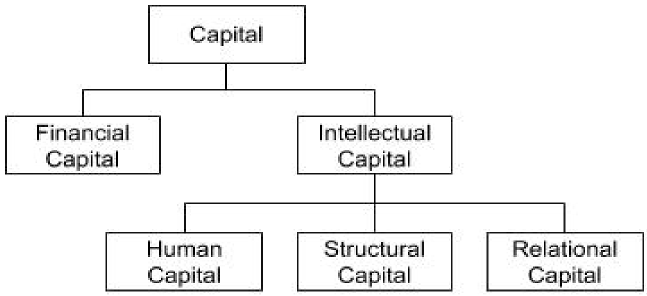

Figure 1. Structure of Intellectual Capital

2.3 Developments in IC management

Value creation process is the core in modern businesses and since a significant amount of value is created by utilizing IC, managers must know how to successfully create value with the given resources in order to achieve the best results. As stated by Kianto et al, (2014) organizations operating in the intangible economy era need to gain insights into the creation, management and measurement of IC. Further, organizations are not able to realize their benefits if their knowledgeable resources and IC are not managed appropriately (Coff, 1997, Widener, 2006). In order to measure the performance of IC, basic economic functions must be developed to include a broader spectrum of what is monitored in order to assist the managers in the value creation process, as mentioned by Asiaei and Jusoh (2015), there are still many challenges concerning the measurement and conceptualization of intangible assets and IC. Clarke et al (2011) highlight such measurement problems as the unavailability of public data, as most of the information tends to be held within the firm, and the information being qualitative and subjective in its nature and therefore being hard to quantify. Tayles et al (2007) argue that management accounting systems need to adapt in order for organizations to capture and control the contribution and value of intangible assets and IC. The management needs relevant information of their strategic assets which is and should be provided through performance measurement systems in order to understand the direct and indirect effect of knowledgeable resources (Kaplan and Norton, 1996).

With the shift to a knowledge-based economy, there has become a need to understand the multidimensional concept of IC in terms of measurements and management. Asiaei and Jusoh (2015) state that there have been complications between scholars to agree on the number of dimensions inherited by IC. Early scholars such as Hudson (1993) presented IC in one dimension with the scope of individual knowledge, while Brooking (1997) and Roos et al (1997) presented more dimensions such as organizational relationships, cultures and intellectual property, and as presented in section 2.1, the three-dimensional model embracing HC, SC and RC has been well recognized by scholars. The concept of quantifying IC arose with the difference between market and book value, and it is still widely used in the financial perspectives to estimate the value of IC. The ease in understanding the concept and the use of the method itself makes this method popular. However, as explained previously, it only gives an estimation of additional prices to book value people are willing to pay for a firm. In addition, it cannot give a comprehensive view into the effect of the individual components of IC, as well as providing any insight into the future performance potential of firms from utilizing IC.

Next, Skandia, a large insurance company from Sweden, was one of the first to attempt to systematically measure and report IC (Bontis, 1996). In 1994, Skandia published a report on intangible assets titled “Visualizing Intellectual Capital” along with its financial statements as a supplement. This introduced the non-monetary model later named the Skandia Navigator, which was developed by Edvinsson and Malone in 1997, where the reporting model had five areas of focus: financial, human, customer, process and renewal and development (Bontis, 2001). In the model, IC is broken down to two components, HC and SC (Dženopoljac *et al.,* 2016) with a focus on customers, which is not as encompassing as RC which includes all other relations such as market relations and relations between firms. The five areas of focus are measured with different IC metrics, where the recommended minimum is 112 (Bontis, 2001). Although innovative for its time, it had its limitations and criticisms of having recommended metrics that rely on assumptions, such as measuring structural capital with the number of computers in a firm where the act of an employee coming to work and sitting in front of a computer is assumed to be translating as the employee transferring knowledge to the firm to create value (Gogan, 2014). Furthermore, the model was developed for a single company in a specific industry and the model should, according to Marr et al (2004), be revised to fit companies operating in different sectors with diverse conditions.

Other notable models include the Residual Income Model (RIM) and Economic Value Added, which is a variation of RIM. Although they are both widely used as a traditional measure of firm’s wealth creation (Mouritsen, 1998), RIM was modified by Ohlson (1995) to include investments in the three components of IC in valuation of firms (Sydler *et al.,* 2014). According to Pulic, these traditional performance methods are not suitable for measuring performances in the context of knowledge economy (Iazzolino and Laise, 2013), and is not able to show “whether and how much value has been created” (Pulic, 2000), since EVA™ only focuses on the efficiency of capital employed. In addition, the result from RIM can be subjective and is difficult to compare them cross-sectionally across firms, for example between firms of different sizes (Thorne *et al*., 2003).

In addition, the Balanced Scorecard (BSC) was developed by Kaplan and Norton (1996) with the aim to measure non-financial aspects of firms such as internal business processes and customer relations. The BSC offers a multidimensional perspective to the firm's performance models, including four perspectives; financial, customer, processes and learning, and growth perspective. The model was a development of the traditional mono-dimension performance measurement models that only account for the financial aspects of firms' performances. Kaplan and Norton (1996) highlight that if organizations "can't measure it, they can't manage it" and state that organizations' performances are positively affected by their ability to measure strategic assets. The authors however, did not explicate their concept of IC when the model was first developed, but rather it was in 2004 the authors first provided their own definition of IC as "human, information and organizational capital" and identifying them in the learning and growth perspective of BSC. This was a divergence in the definition of IC from the almost converging general definition of IC which divided IC into HC, SC and RC (Marr and Adams, 2004). The shift from a strategic management tool, solely including the perspectives of financial, customer, processes and learning, and growth, to also include IC in order to develop an IC management tool, has created different opinions among scholars. Some consider BSC as a fundamental tool (Sveiby, 2009; Zambon, 2003) while others consider BSC not to be a model created to measure IC ad hoc (Mouritsen et al., 2005; Lev, 2001). Further limitations of the model are that BSC is better suited for measuring a firm's overall performance rather than just IC (Kong, 2010), and that it does not include a focus on human resources of organizations which is a large and important component of IC (Maltz *et al.*, 2003) as well as the fact that the model can be rigid as indicators are forced into one of the four perspectives, and that the model lack flexibility and limit the view of the company for its specific situation (Molleman, 2008; Voelpel *et al*., 2006).

Lastly, in the year 2000, Ante Pulic came up with a new model that was built on the earlier solution Skandia Navigator. The model was developed in order to account for the yet unsolved aspects of earlier models, namely; how financial and intellectual capital can be leveraged, adequate for measuring efficiency performed by employees, an alternative to determine IC value on companies that are not on the stock market. Pulic (2000) presented the model in the academic article “VAIC^{TM} - an accounting tool for IC management”, where the term “Value Added Intellectual Coefficient " was first introduced, a coefficient that indicates corporate value creation efficiency. VAIC^{TM} is one of the latest models that impacted the subject of IC significantly (Dumay, 2014; Pedro *et al*, 2018) and arose a widespread usage of the model by many scholars in examining IC of firms in a variety of contexts using the VAIC^{TM} model with more than 30 studies conducted over the past decade (Nazari and Herremans, 2007; Ståhle *et al.*, 2011). The model uses data from traditional financial statements to analyze ‘value creation efficiency’, which measures IC performance (Laing *et al.*, 2010).

The model offers an additional measure of IC, by including physical capital, human capital and structural capital by not measuring the value of IC, but rather focusing on the value created from IC to understand firms’ IC performance (Iazzolino and Laise, 2013). The model gives a theoretical and practical approach, which consists of five steps. The first step is related to how companies create Value Added (VA), which is the difference between companies’ output and input, and for the next step the value added are put in relation to capital employed and the amount of physical, financial and intellectual capital in order to answer how efficiently value has been created by the company. Next, the efficiency of IC and its two components HC and SC are calculated, and as a third step the relation between VA and employed human capital are calculated, which show the value created by one unit of investment in the employees. The fourth step is to calculate the relation between VA and employed structural capital, which indicates the share of SC in the created value. The last step consists of finding how successful each resource answers in the achieved VA. These steps give the final value of VAIC^{TM}, where the higher the value, the better utilization of the company’s IC and its potential. The model is derived from public quantitative data that is disclosed in financial statements, the model is therefore suitable for a statistical model as the input data to the model is widely available (Andriessen, 2004). The data is further legitimate and credible, as the input data in the model is based on audited information (Firer and Williams, 2003). The availability of data further opens up for objective comparisons between firms, as well as it will aid to create an understanding of the efficiency change from year to year within a firm. The model however, only includes capital employed, HC and SC, and is missing the last component of IC, RC, therefore not giving the most accurate coefficient and as literature suggests, relation of firms with their environments such as customers, shareholders and competitors are considered to be an important factor in firms’ IC (Bontis, 1998; Bozbura, 2004).

Related to the limitations of the original VAIC™ model, the extended model of VAIC™ has been developed by scholars to be able to measure IC in a more complete scope, in line with the converging general definition of IC (Marr and Adams, 2004) and now accounts for RC, the third component of IC, along with HC and SC. In the study by Chen *et al.* (2005), RC and innovation capital is included as control variables to the original VAIC™ model as a way to provide a better explanation of SC, which regarding to the authors may be incomplete. Their strategy to measure the two sub-components of SC, is made by using R&D and advertising expenses as proxies for innovation capital and relational capital, which should be seen as investments instead of costs as it will impact technological advancements and brand value (Chen et al, 2005), in order to account for the size effect, the proxy variables are divided by book value of common stocks. Similarly, in a study by Phusavat *et al.* (2011), R&D is used as a proxy for innovation capital, however, the authors include innovation capital as an efficiency variable, and calculate the variable as R&D expenses in proportion to VA, which therefore is calculated in the same way as Pulic (2000) calculates SC efficiency in the original VAIC™ model. Chang and Hsieh (2011) further includes innovation capital efficiency in their extended VAIC™ model, where innovation capital is measured by using R&D expenses as a proxy. However, in order to calculate innovation capital efficiency, the authors calculate the variable as R&D expenses in proportion to book value of common stocks compared to R&D expenses to VA, as calculated by Phusavat *et al.* (2011). Scholars prevalent include RC in their extended VAIC™ model (Ulum *et al.*, 2014; Nimtrakoon, 2015; Vishnu and Gupta, 2014, 2015; Chen et al, 2005), the variable is however calculated in different ways. Ulum et al (2014) and Nimatrakoon (2015) calculate the variable as the ratio between marketing expenses to VA, while Vishnu and Gupta (2015) define the variable as marketing, selling, and advertising expenses in relation to VA. Chen *et al.* (2005) instead includes relational capital as advertising expenses, but not formulated as an efficiency measure and put in relation to VA.

2.4 Strengths and Limitations of VAIC™

VAIC™ may offer a practical solution which provides information on IC performance and insights into IC efficiency. The model is a development of the Skandia Navigator model, which further contributes in tackling the incomplete journey to quantify IC and complementing earlier models of IC measurements such as EVA™ and BSC (Pulic, 2008) by measuring 'value added' as an indicator of value created from knowledge work productivity from looking into the different costs invested by firms to give insight into their IC performance (Iazzolino and Laise, 2013). The VAIC^{TM} model is viable with publicly available firm data derived from financial reports, unlike other earlier models, indicating legitimate and verifiable source of information that is based on audited information. The source of data alleviates many of the earlier mentioned measuring issues such as unavailability of data and the qualitative and subjective nature of the information on IC that makes it hard to quantify. It also enables the model to provide standardized, consistent and objective measures (Shiu, 2006), further opening up for clearer comparisons among organizations in various sectors, both local and international (Maditinos *et al.*, 2011; Murale *et al.*, 2010). The fact that the model can be calculated based on these figures alone make it easy to be applied, helping with the ease of comparison aspect of the model (Ståhle *et al.*, 2011). Furthermore, Iazzolino and Laise (2013) claim that one of the main strengths of Pulic's innovative proposal is that it creates a link between the notion of value added and IC, contributing to Pulic's aim for the model of measuring and monitoring value added from knowledge resources.

In terms of the limitations of the model, Iazzolino and Laise (2013) argue in line with the critique by Ståhle *et al*. (2011) that Pulic uses a radically different sense of the term of HC and SC compared to the assigned meaning in the Skandia Navigator model that Pulic used to build his model upon. Pulic calculates the components of IC directly from company accounts, where in reality the component encompasses many different factors. This causes many factors that are not in the financial statements or in Pulic's definition to be unaccounted for, possibly causing them to be oversimplified and in the end undervalued. For example, the VAIC^{TM} model's definition of HC as just human resources costs is much more simplified than in reality, where HC contains other factors such as employees' skills, experience, motivation and training. This creates a misunderstanding as the concept of IC used by Pulic is not in line with other literature on knowledge management, the broad agreement about the scope and distinction of intellectual capital that has become a taxonomical understanding among scholars (Sveiby, 1980?; Edvinsson and Malone, 1997; Sullivan, 1997; Andriessen and Stam, 2004), creating semantic confusion due to the terms being used with a different meaning (Ståhle *et al*., 2011).

Pulic defines all costs related to employees as investments, which is criticized by Andriessen (2004), suggesting that Pulic is said to confuse costs with assets and that the "VAIC^{TM} method does not properly separate expenses from assets" (Andriessen, 2004). The knowledge of employees is used but not owned by the firm, and therefore according to the fundamental accounting principle, it cannot be in the balance sheet as an asset and as for the costs related to employees, some costs can benefit firms in the future but the majority don't and therefore should be recorded as merely expenses (Andriessen, 2004; Fijałkowska, 2014). This critique is neglected by Iazzolino and Laise (2013) who suggest that costs related to employees are investments since the firm is expecting a return from the expense, and therefore indeed can be assets (Iazzolino and Laise, 2013). They maintain that Pulic does not in fact contradict fundamental accounting principles and does not confuse between expenditure and assets, and that Pulic's message is solely misunderstood.

Further, since the model is an aggregation of different components, firms using resources inefficiently in one area can still have a high coefficient by being more efficient in another area, possibly making it difficult to see a firm's IC performance in the individual components (Fijałkowska, 2014). In addition, as mentioned earlier, the original VAIC^{TM} model can be seen as being incomplete due to the lack of measurement of RC. However, this limitation is eliminated with the introduction of the extended VAIC^{TM} model that is able to give a more complete picture by including RC as well as innovation capital, and allowing one to alter the model to be able to accurately measure the scope of a firm's IC.

2.5 Motivation for use of extended VAIC^{TM} model

VAIC^{TM} model has exploded in popularity since it was introduced in the year 2000, being widely used by scholars in many different countries as one of the most popular ratios used in evaluating IC (Sledzik, 2013; Ulum *et al.*, 2014). As for the model itself, the data used in order to calculate VAIC^{TM} are derived from financial statements, and are therefore an objective method enabling us to compare companies to each other, as highlighted by Firer and Williams (2003) many other developed models of IC lack the comparability aspect as many models are tailored to fit the profile of a specific firm. The VAIC^{TM} model further contributes with a technique that acts as a bridge between VA and IC, where the value created by IC can be examined. As mentioned by Iazzolino and Laise (2013) VAIC^{TM} measures one dimension of firm performance and are therefore a complement to other methods such as the BSC, Skandia Navigator Model and EVA^{TM}-model. Further as mentioned by Shiu (2006), VAIC^{TM} is a standardized and logical method that is straightforward in measuring IC efficiency. An extended VAIC^{TM} model will be used as it accounts for IC components that were missing in the original model, namely relational capital and innovational capital.

2.6 Previous applications of VAIC^{TM}

With the development in IC measurements and the introduction of VAIC^{TM}, many scholars have conducted studies of the effects of IC on firms' financial performance with the use of VAIC^{TM}. Mondal and Ghosh (2012) investigated the impact of IC on financial performance of 65 banks in India, where they found that the higher value of VAIC^{TM}, the better ROA and ATR (Asset Turnover Ratio) tended to be, establishing that IC had significant influence on profitability and productivity for Indian banks. Chang (2007) found that in Taiwan's IT industry, there was a significant relationship between better IC efficiency resulting in higher market value and profitability. Pulic (2004) found that banks that spent more on IC had better financial performance and were more profitable. Tan *et al.* (2007) examined 150 listed firms on the Singapore Exchange and found that IC not only had a positive correlation to the firms' current performance, but also their future performance. In addition, they noticed varying degrees of the relationship between IC and performance in different industries.

However, there have been others who had different conclusions about the relationship. Joshi *et al.* (2013) investigated the relationship on the Australian financial services sector, where they found that out of the three components of IC, HC had the largest impact on IC performance and creation of value, but they could not find that higher IC necessarily lead to a higher financial performance, to which they speculate the reason to be that IC that are not appropriately managed lower financial performance. Morariu (2014) has even found a negative relationship between IC and firms' financial performance, in analyzing a sample of Romanian firms.

2.7 Hypotheses development

Since the business environments have changed to a knowledge intensive industry and knowledge and IC has become important resources contributing to success in firms, firms that adapt to the most appropriate environment and use IC to gain competitive advantage should achieve a better financial performance and market perception as a result in line with the contingency theory and resource-based view. In addition, due to the advanced IC development and acknowledgement of its importance in Swedish firms, we predict that a higher IC management and efficiency will have a positive effect on both firm performance and on market valuation. However, the relationship in question can vary in different contexts and the precise extent to which IC's effect would be captured through financial measures in Swedish firms is uncertain and can contribute to the existing literature.

This thesis will therefore be the first to combine previous methodologies to empirically examine the relationship between IC and financial performance and market value in the context of Swedish listed firms using the extended VAIC^{TM} model as a proxy for IC. This leads to our hypotheses:

H1. The value of VAIC^{TM} is positively associated with financial performance.

H2. The value of VAIC^{TM} is positively associated with market-to-book value.

Understanding the detailed insight of the relationship and contributing insightful information to managers that are in demand of an understanding of how to successfully add value by their knowledge resources can create an understanding of the direct and indirect effect of these resources and lead to a better IC management. IC is a multidimensional concept consisting of the three components, HC, SC and RC. In the extended VAIC^{TM} model by Phusavat *et al.* (2011) innovational capital is further included as one of the efficiency variables of IC to see its standalone impact on the relationship. In order to present an understanding in a detailed scope we will therefore analyze each component of IC in relation to firm performance and market value to observe the individual impact of them in Swedish firms. This leads to the rest our hypotheses:

H1a. Human capital is positively associated with financial performance.
H1b. Structural capital is positively associated with financial performance.
H1c. Relational capital is positively associated with financial performance.
H1d. Innovational capital is positively associated with financial performance.

H2a. Human capital is positively associated with market-to-book value.

H2b: Structural capital is positively associated with market-to-book value.

H2c. Relational capital is positively associated with market-to-book value.

H2d. Innovational capital is positively associated with market-to-book value.

3 Research methodology

3.1 Methodological approach

The overall approach to the thesis is of a quantitative nature, and in order to test the constructed hypothesis we will run multiple ordinary least squares (OLS) regressions and panel data regression methods, in order to find the impact of each component of IC on firm performance and on the market to book value ratio. OLS regressions is a statistical method of analysis that estimates relationships between variables. By performing OLS regressions we will be able to research if Swedish listed firms are efficient in utilizing their IC and further be able to find the value of the coefficient to evaluate if the impact is positive or negative. We will also use a panel data technique because of the longitudinal format of the sample, as the estimates from the OLS regressions may be of limit and subject to omitted variable bias. A statistical approach is suitable in order to answer our research questions, and further in the field of the topic, similar methodology has been widely used in previous papers researching the impact of IC and its proxy variable VAIC^{TM} on different dependent variables such as firm performance measures (Chan 2009, Shiu 2006, Chen 2005, Javornik et al 2012). Justification of the statistical approach can be argued to be as it goes in line with papers in the quantitative field researching the impact of one variable on another.

3.2 Sample description

The firms examined in this study are 56 firms listed at Nasdaq Stockholm within the healthcare sector. The companies are listed at both the small cap, mid cap and large cap indexes. The companies were divided upon the Industry Classification Benchmark (ICB), which can be used to segregate markets into sectors, the companies of interest are included in the 4500 healthcare classification. Data are gathered over 10 years for each firm between the years 2009-2018. The data of the study were mainly collected from databases such as Retriever Business, Bloomberg and S&P Capital IQ, with data that is based on the companies' annual financial reports, information that could not be received from databases where complemented with data manually collected and processed from firms annual reports and public information on the companies' websites. The data retrieved for the market to book ratio is the average value over a year. R&D is collected from the financial statement and in the footnotes. The components of the development and the research expenses are presented as a sum, and the details are not released further. The total number of observations is 460. The sample follows a long format data with a panel data structure, as the sample includes a pooling of observations in a cross-section of 56 firms within the healthcare sector, which contains observations collected at a regular frequency per year over a period of 10 years (2009-2018). The observations in the sample therefore include two dimensions; a cross-sectional dimension of different firms, and a time series dimension of a period by 10 years. Since some of the groups in the sample have missing values at some of the time observations, the data follows an unbalanced panel dataset. The reason for missing data is mainly because some companies in the sample were registered and listed later than 2009 and therefore did not have any information for all observations. A panel descriptive statistic of the variables is conducted to understand the variables' standard deviations and means in detail, which is shown in the appendix table 1.

3.3 Method of analysis and variables used

3.3.1 Dependent variables

In order to test whether financial performance and market values in firms are higher or lower due to IC, the variables must be carefully selected that will reflect the appropriate reality. The dependent variables measuring firm performance are ROE, ROA and ATO (asset turnover), and the dependent variable measuring market value is MB (market to book ratio). The measures are commonly used proxies for measuring financial performance and market value, and within the financial performance measurement, ROE and ROA are described in previous studies to determine firm's profitability, whereas ATO determines firm's productivity (Mondal and Ghosh, 2012; Firer and Stainbank, 2003; Firer and Williams, 2003; Chen *et al*., 2005;Chang 2007).

(1) *Return on Equity* (*ROE*):

ROE = Net Income/Shareholders Equity

ROE is considered to be “one of the most important financial ratios” (Chang, 2017) that measures financial performance and profitability by the efficient use of assets and shareholder investments to generate profit.

(2) *Return on Assets* (*ROA*):

ROA = Net Income/Total Assets

ROA measures how efficiently assets are turned into profit and is traditionally used as a measure of financial performance and profitability.

(3) *Asset Turnover* (*ATO*):

ATO = Revenue/Total Assets

ATO measures how efficiently assets are turned into purely sales, and is used as a measure of financial performance and productivity.

(4) Market to Book ratio (*MB*):

MB = Market Capitalization/Total Book Value

MB simply captures how much the market value of a firm is in comparison to its book value, and can give insight into whether a firm is under or overvalued.

3.3.2 Independent variables

The independent variables used are based on the original VAIC™, with some alterations from the extended VAIC™ model. VAIC™ as a proxy indicates and evaluates the total efficiency of value added or created by the capital employed by the firm, and therefore a higher VAIC™ will indicate a higher efficiency in value creation (Pulic, 2000). The first step is to calculate in firms what is called in the model value added (VA), with the original formula calculated as:

Original: VA = Output − Input

where output is the net sales revenue and the input is the cost of goods sold. The notion of value added is proposed by Pulic, which is described as “an objective indicator of business success and shows the ability of a company to create value” (Pulic, 2004), which includes investments in resources and future development. In the extended VAIC™ model, RC and innovation capital are added and therefore they should be reflected on the calculation of VA. The modified formula for VA, presented by Bayraktaroglu *et al.* (2019) beneath, where labour expenses are excluded from sales, marketing and distribution and R&D expenses to prevent duplication, since it includes all types of employee-related costs.

Extended: VA = Output (Gross margin)−Input (Sales, general and administrative expenses) +Labor expenses+Sales, marketing and distribution expenses (labor expenses excluded) +R&D expenses (labor expenses excluded)

The next step is to calculate the efficiency of a firm's three IC components plus capital employed and innovation capital in relation to VA. In the extended VAIC™ model, human capital efficiency (HCE), structural capital efficiency (SCE), relational capital efficiency (RCE), capital employed efficiency (CEE) and innovation capital efficiency determined by R&D (RDE) are calculated as follows:

HCE = VA/Labor Expenses

CEE = VA/Capital Employed

RCE = VA/Sales, Marketing and Distribution Expenses

where labor expenses are the total salaries and wages expense for a firm and capital employed is the physical and financial assets that combine with IC to create value, calculated as book value of net assets.

Pulic (1998) calculates SC as VA minus HC, as VA is affected by both SC and HC, making SC and HC inversely proportional, resulting in an increase in HC decreasing SC. However, this is logically inconsistent with the definition of SC, and to fix this problem Pulic (1998) calculates SCE as:

SCE = SC/VA

This allows for an increase in HCE to also increase SCE (decrease in HC increases HCE, which also increases SC, therefore leading to an increase in SCE as well). SCE for our extended model is shown below:

$$SCE = (VA - \text{Labor Expenses} - \text{Sales, Marketing and Distribution Expenses} - \text{R\&D Expenses})/VA$$

Since R&D (innovation capital) is considered as a sub-component of SC, measurement of RDE follows the same logic and is calculated as:

$$RDE = \text{R\&D expenses}/VA$$

Finally, the extended VAIC^{TM} incorporates the five efficiency measures into one index:

$$\text{Extended VAIC}^{TM} = HCE + SCE + RCE + CEE + RDE$$

3.3.3 Control variables

In order to isolate the effect of IC on the dependent variables, leverage and size of the firm are included in the regression formulas as control variables accounting for financial performance, in line with Mondal and Ghosh (2012), and firm age and firm size included in the regression models in order to control for market to book ratio, in line with Keloharju and Kulp (1996).

1. Leverage (DE): Debt-to-equity ratio, measured by total debt divided by book value of total equity. It is useful in controlling debt servicing in measuring financial performance (Riahi-Belkaoui, 2003).
2. Firm age in years (FA): Used as a proxy for growth opportunities in firms. Growth opportunity is one of the components of and has an impact on market value (Myers, 1977), and as firms grow older, their growth opportunities tend to decline (Navaretti *et al.*, 2014). Therefore, using firm age is useful in controlling for growth opportunities in measuring market to book value.
3. Size of the firm (LTA): Calculated as natural log of total assets of firms. It is used to control for the impact of firm size on financial performance, as our sample firms will be from all ranges of firm sizes.

3.4 Regression models

In order to test our hypotheses on the relationship between the financial performance and the independent variables of the extended VAIC™ model, we will have 8 regression models where the first four will test the association of VAIC™ with ROA, ROE, ATO and market to book value, and the last four will be used to analyze each of the three components of IC individually on firm performance and market to book value.

Model 1:

$$ROA = \alpha + \beta_1(VAIC) + \beta_2(LTA) + \beta_3(DE) + \varepsilon$$

Model 2:

$$ROE = \alpha + \beta_1 (VAIC) + \beta_2(LTA) + \beta_3(DE) + \varepsilon$$

Model 3:

$$ATO = \alpha + \beta_1 (VAIC) + \beta_2(LTA) + \beta_3(DE) + \varepsilon$$

Model 4:

$$MB = \alpha + \beta_1 (VAIC) + \beta_2(LTA) + \beta_3(FA) + \varepsilon$$

Model 5:

$$ROA = \alpha + \beta_1(HCE) + \beta_2(CEE) + \beta_3(RDE) + \beta_4(RCE) + \beta_5(SCE) + \beta_6(LTA) + B_7(DE) + \varepsilon$$

Model 6:

$$ROE = \alpha + \beta_1(HCE) + \beta_2(CEE) + \beta_3(RDE) + \beta_4(RCE) + \beta_5(SCE) + \beta_6(LTA) + \beta_7(DE) + \varepsilon$$

Model 7:

$$ATO = \alpha + \beta_1(HCE) + \beta_2(CEE) + \beta_3(RDE) + \beta_4(RCE) + \beta_5(SCE) + \beta_6(LTA) + \beta_7(DE) + \varepsilon$$

Model 8:

$$MB = \alpha + \beta_1(HCE) + \beta_2(CEE) + \beta_3(RDE) + \beta_4(RCE) + \beta_5(SCE) + \beta_6(LTA) + \beta_7(FA) + \varepsilon$$

3.5 Model estimation

The data in the sample are unbalanced panel data, where multiple entities are repeatedly measured at different time periods. The same entities are measured for each period and the panel data are therefore a fixed panel (Greene, 2008). According to Baltagi (2001) panel data offers more informative data, variability, degree of freedom and more efficiency together with less collinearity among the variables as long as the panel data is well-organized. The method further provides ways of dealing with heterogeneity while also examining fixed or random effects. A panel study will further control for omitted variables by observing changes in the dependent variable over time. In order to control for correlation and the relationship between the variables, a Pearson Correlation Matrix is performed (Appendix Table 5). Furthermore, variance inflation factor (VIF) values are calculated after the regressions to check for multicollinearity problems. The sample is trimmed with a winsor2 test to disregard the outliers in the 1 and 99 percentiles. The regressions for all the models are performed with clustered standard errors to get modified standard errors that control for heteroscedasticity in the data, which clusters the standard deviation upon the firms in the regressions. The regressions are first performed with a fixed effect model, which is used when the group means are non-random. This model fits best with the data for various reasons. First, the firms are chosen within a specific industry with multiple repeated measures from the same firms. Therefore, the variables measured, and the parameters are not likely to be random in nature. In addition, a fixed effects model is often used when the independent variables are specifically chosen to examine the dependent variables' response (Salkind, 2010 add in reference). Finally, omitted variables exist in the data that correlate with the variables in the model, the fixed effect model provides a means to control for omitted variable bias (Williams, 2018). Standard OLS regressions are performed afterwards on the dependent variables against VAIC^{TM} and its components, in order to be able to compare the results from the panel studies with fixed effect models.

4 Results

4.1 Data description

The sample consists of 56 listed firms within the healthcare sector in Nasdaq Stockholm with observations from 2009 to 2018, shown in Table 1 in the appendix. Most variables have a total sample size of 460 observations, due to some firms not having existed in some of the years. Furthermore, market to book value's total observations are 378 due to some firms being in operation but not yet being listed until later years, resulting in a smaller sample size than others. As shown in the result, the standard deviations are fairly high for the variables ROA, ROE, VAIC^{TM} and its individual components. This is due to the dispersed value and outliers in the data which comes from companies within the healthcare sector belonging to different sub-sectors with varying operations. Some firms are more focused into research and development and are in relatively early stages of their business, and therefore have high costs with low revenues, whereas other firms have fully functioning operations with large revenues. This results in the high standard deviation, which can be seen in ROA and ROE's minimum and maximum value of -380.5 to 128.5 and -2,131.3 to 400.1, with a standard deviation of 44.841 and 159.944, respectively.

Descriptive Statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
ROA	460	-12.754	44.841	-380.5	128.5
ROE	460	-31.199	159.944	-2131.3	400.1
MB	378	5.291	5.99	.44	63.77
DE	460	.697	2.299	-22.526	17
FirmAge	460	21.161	21.347	0	106
HCE	460	1.763	10.039	-146.667	127.151
CEE	460	.042	7.79	-153.068	9.343
RDE	460	-.119	5.311	-80.392	57.641
RCE	460	10.819	34.902	-18.53	248.884
SCE	460	.826	14.145	-115.286	253.647
VAIC	460	13.329	39.113	-150.691	251.068
LTA	460	6.142	2.23	-.42	13.25
ATO	460	.621	.653	0	4.018

Table 1. Summary statistics of the sample

Descriptive Statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
ROA	460	-12.168	38.796	-204.8	47.9
ROE	460	-27.159	110.663	-751	117.47
MB	378	5.291	5.99	.44	63.77
DE	460	.697	2.299	-22.526	17
FirmAge	460	21.161	21.347	0	106
HCE	460	1.763	10.039	-146.667	127.151
CEE	460	.042	7.79	-153.068	9.343
RDE	460	-.119	5.311	-80.392	57.641
RCE	460	10.819	34.902	-18.53	248.884
SCE	460	.826	14.145	-115.286	253.647
VAIC	460	13.329	39.113	-150.691	251.068
LTA	460	6.142	2.23	-.42	13.25
ATO	460	.621	.653	0	4.018

Table 2: Summary statistics of the sample without outliers for ROA and ROE, at the 1 and 99 percentiles.

Further, the standard deviation for VAIC^{TM} is 39.113, which is slightly high when compared to the mean value of 13.329. In order to control for outliers, the winsor2 command at the 1 and

99 percentile were performed. As the outliers primarily come from extraordinarily low revenue in some firms, ROA and ROE are the variables targeted. As presented in table 2 in appendix, by correcting for the outliers the standard deviation decreased to 38.798 for ROA and 110.663 for ROE. In addition, many of ROA and ROE values being negative will not be an issue as we speculate that inefficient usage of IC will result in more negative values. As for the VAIC^{TM} variable and its components, since they are calculated from many different accounting numbers, the outliers were not removed as it could result in valuable information being removed. In addition, unlike ROA and ROE the standard deviations for VAIC^{TM} and its components were not extremely high compared to the mean, and therefore not removing the outliers would be more beneficial than removing them.

4.2 Fixed-effect model

The regression result of the four dependent variables against VAIC^{TM} all have p-values higher than 0.05, and therefore show no significant relationship between the variables at a 95% confidence interval, presented in Table 4. Table 5 shows the result of the regressions against the five individual components of VAIC^{TM}, where more significant relationships are observed. CEE has a regression coefficient of -0.375 and -1.029 at a significance level of 5% for ROA and ROE, whereas HCE has a regression coefficient of 0.00235 for ATO. In addition, no components of VAIC^{TM} had a significant impact on the market to book value of firms.

VARIABLES	(1) ROA	(2) ROE	(3) ATO	(4) MB
VAIC	-0.0656	-0.375	0.000760	0.00279
	(0.0657)	(0.243)	(0.000701)	(0.00492)
LTA	10.56***	26.78***	-0.0981***	-1.812
	(2.886)	(9.724)	(0.0317)	(1.134)
DE	-0.767	-14.76**	0.0113	
	(0.682)	(6.599)	(0.00686)	
FirmAge				0.371
				(0.311)
Constant	-75.59***	-176.3***	1.205***	8.015
	(17.46)	(57.90)	(0.190)	(5.300)
Observations	460	460	460	378
R-squared	0.153	0.219	0.128	0.037
Number of firmid	56	56	56	56

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3: Fixed-effect regressions with clustered standard errors on firmid for VAIC^{TM}

VARIABLES	(1) ROA	(2) ROE	(3) ATO	(4) MB
HCE	0.0188	-0.356	0.00235**	-0.0154
	(0.283)	(0.459)	(0.00102)	(0.0330)
CEE	-0.375***	-1.029***	7.61e-06	0.0389
	(0.0678)	(0.376)	(0.000875)	(0.0359)
RDE	-0.124	-1.272	-0.00165	0.136
	(0.799)	(4.058)	(0.00264)	(0.0980)
RCE	-0.00390	-0.198	0.000740	-0.000182
	(0.0595)	(0.238)	(0.000880)	(0.00610)
SCE	-0.244	-1.061	-0.000630	0.0400*
	(0.333)	(1.130)	(0.00106)	(0.0229)
LTA	10.93***	27.83***	-0.100***	-1.761
	(2.920)	(10.26)	(0.0330)	(1.245)
DE	-0.772	-14.69**	0.0113	
	(0.671)	(6.518)	(0.00691)	
FirmAge				0.379
				(0.326)
Constant	-78.54***	-184.3***	1.217***	7.545
	(17.64)	(61.67)	(0.198)	(5.372)
Observations	460	460	460	378
R-squared	0.171	0.228	0.133	0.040
Number of firmid	56	56	56	56

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Fixed-effect regressions with clustered standard errors on firmid for individual components of VAIC^{TM}

4.3 Robustness check

4.3.1 Multicollinearity

Pearson correlation and VIF are performed to check for potential multicollinearity problems, with the results presented in Table 3. As a general rule, the r value higher than 0.5 in the Pearson correlation test between variables describes a strong correlation that indicates the presence of multicollinearity, and a VIF value greater than 10 also indicates a multicollinearity problem. The result shows that none of the dependent variables for the different models had a correlation value of higher than 0.5 with the dependent and control variables. The only notable results are seen between the independent variable VAIC^{TM} and its individual components, RDE and SCE with correlation of -0.841, and between RCE and VAIC^{TM} with correlation of 0.905. The high correlation between VAIC^{TM} and RCE is not a concern since they are never used together in the same model, but the strong association between RDE and SCE could raise a concern. However, a separate model that excludes one of the variables was performed and no differences in result occurred. The VIF numbers on the other hand indicates no multicollinearity between all variables, with the value for all the proposed models varying between 1.07 and 1.74, which are within the acceptable range for multicollinearity to not be a serious issue.

4.3.2 OLS-regression

The results from the OLS regression models presented in Table 6 shown in the appendix indicate no significant difference in the result of the relationship in the variables from the fixed effects model. The coefficients of VAIC^{TM} are non-significant for all models, as it was in the fixed effects model. The coefficients are slightly smaller than the fixed effect model for ROA and ROE, with coefficients of -0.0290 and -0.0784, and positive for ATO and MB, 0.00144 and 0.000549. The coefficient of VAIC^{TM} on ATO was however larger than in the fixed effects model, with a coefficient of 0.00076. However, the p-value still is not significant enough to establish any relationship between the explanatory and independent variables. In Table 7 (appendix), regressing the components of VAIC^{TM} on the dependent variables show no significant impact of HCE, and RCE on any of the dependent variables. However, for CEE we can see a significant impact at a 10% level on MB. Furthermore, for RDE and SCE, the result indicates a significant relationship at a 1% level on ROE and MB. The coefficients of CEE, RDE and SCE show a positive impact on MB, with the coefficients of RDE and SCE showing a negative impact on ROE. The results differ from the fixed effect models, where HCE is significant at a 1% level on ATO, and CEE is significant at the 1% level on ROA and ROE. The direction of the coefficients is however the same.

4.4 Discussion

The results indicate that contrary to the *H1* and *H2*, VAIC^{TM} did not have a significant impact on firm performance and market to book value. VAIC^{TM} is used as a proxy for efficient usage of IC in firms, and in theory and literature a more resourceful usage of IC should be beneficial for increasing firm performance and market to book value. The result however shows that developing more IC and using it efficiently for the firms in question did not improve their financial and market performance, and that no substantial relationship could be established Swedish listed firms in the healthcare sector. In line with Morariu (2014) and Joshi *et al.* (2003)'s study where the results showed a negative relationship between VAIC^{TM} and financial performance, the insignificant result could be due to the fact that the firms might not be properly managing their existing IC to create a competitive advantage in the future. In addition, the relationship can vary between industries (Tan *et al.*, 2007) and in our data of the healthcare sector, many firms were vastly focused on increasing IC through research and development while having minimal operations and high costs. This lowers a firm's financial performance even with an efficient IC usage, potentially contributing to deviations in the results.

Looking at MB, efficient use of IC did not turn out to be a factor in determining firms' market to book values. Our initial prediction was that since Sweden is a country with advanced development in the concept of IC and healthcare being an IC intensive industry, an efficient usage of IC in firms would lead to a higher market valuation. However, the result shows that high IC development in firms does not necessarily impact their market value, suggesting that at least for the healthcare industry in Sweden, the market still primarily puts emphasis on firms' tangible assets in evaluating rather than intangible assets.

Delving deeper into the associations of the explanatory variables and the individual components of VAIC^{TM}, the result provides some useful insight. Most of the components remain insignificantly associated with the explanatory variables except for HCE and CEE. CEE can be seen as the counterpart of the other four components of VAIC^{TM} in that it is the financial capital used in conjunction with IC to create value. The notable result of the negative regression coefficients of ROA and ROE when regressed against CEE shows that when firms employed capital more efficiently, their financial performance decreased. This could indicate again that the capital may be employed efficiently, but that the firm is not able to manage it well internally to create value. It could also be due to an unexplained variable missing within the capital employed variable that is affecting the relationship. For HCE on the other hand, our result indicates a positive and significant impact on ATO, in line with Joshi et al (2013) who found that HC had the biggest impact on IC performance and creating value. From this result we can interpret that the firms in the sample are efficiently using their human capital which in turn has a positive effect on ATO, the firm's productivity. The coefficient and impact is relatively small compared to other variables', with a value of 0.00235, indicating that a one unit increase in HCE increases the ATO 0.00235. The firms in the sample with an efficient human capital usage lead to improved productivity within the healthcare sector, potentially highlighting that in this specific industry, human capital is the focal point in terms of IC when trying to improve productivity. The result also follows the resource-based theory where having strategic resources that are valuable in various ways can be a source of competitive advantage for firms. As Hall (1992) and Madsen *et al.* (2003) suggest, enhancing HC by hiring valuable employees with knowledge and expertise can bring success to firms and in this case, it showed to contribute to a higher productivity within the healthcare sector.

Furthermore, the VAIC^{TM} component SCE had an impact on MB at a 10% significance level, indicating that a one unit increase in SCE increased MB by 0.04 units. Although not as robust as other findings with a 5% significance level, this could still indicate a relationship. The result could suggest that while the market does not react to the overall IC efficiency, the structural capital is one aspect of IC that gains the market's attention for the healthcare industry. Structural capital encompasses many important assets for the healthcare firms, including intellectual property such as patents and copyrights, which can be a major factor for the market to consider. In addition, since structural capital is owned by the organization and remains even when for example human capital is removed, the market could view it as the more "tangible" intangible asset out of the other IC components, hence the positive association between SC and MB.

The result for SCE also follows the contingency theory, which highlights the paradigm of the fit-performance relationship where organizations are said to gain effectiveness by adopting to its contingencies. The non-significant result from the main regressions measuring VAIC^{TM} in relation to the firm performance and MB could indicate from a contingency theory perspective that Swedish firms within the healthcare sector is not optimally fit between its characteristics and its contingencies. However, this can be explained by other factors which instead can stem from the nature of the industry and firm when it comes to measuring firm performance with mainly ROA and ROE. The IC component of SCE, on the other hand, indicates a significant positive relationship to MB, indicating that the market and investors may be putting more value in the development of SC within IC than others, and that the healthcare firms are adapting their SC well to their contingencies to see improvement in their market value from doing so. The relationship between SCE and MB can also be explained in line with the resource-based theory, where strategic resources are valuable and rare resources that are difficult to imitate. Within the healthcare sector, many firms concentrate high amounts of investments into research and development with the goal of inventing strategic resources, further grouped into intellectual properties protected by patents. The market's perspective from the result of our regression value of a unit increase in SC resulting in 0.04 unit increase in MB may act to enhance the importance of the SC component of IC.

The control variable firm size was shown to have significant influence on both financial performance and productivity, whereas the leverage was only impacting ROE and not any other explanatory variables. In addition, none of the control variables were shown to have an impact on market to book value, indicating that a potential improvement could be made in terms of control variables to establish a higher explanatory relationship.

5 Conclusion

This thesis contributes to the existing IC literature by studying the effect of IC on firm performance and market to book value in a new context, in Sweden with a more developed awareness in terms of IC compared to the existing literature, using an extended VAIC^{TM} model that encompasses more detailed aspects of IC in firms. The new model, following Bayraktaroglu and Baskak (2019), introduces additional components to the original VAIC^{TM} and alters the calculation of value added to adjust for the changes, and therefore is potentially a better indicator than the original VAIC^{TM} model. According to our results for Swedish healthcare firms, overall IC indicator VAIC^{TM} did not have a significant influence neither firm performance nor market to book value. However, some individual components of VAIC^{TM} were shown to have various impacts on the explanatory variables, namely capital employed, human capital and structural capital. Enhancement in capital employed negatively affected firms' financial performances, possibly due to other aspects of IC not being efficiently managed together with the capital employed. Higher quality of human capital resulted in a higher productivity in firms, and finally structural capital showed a positive influence on market to book value, although to a less statistically significant degree, indicating that the Swedish market might still favor firms to exert more effort on improving the traditional tangible assets rather than intangible assets.

The results from this thesis may be reflected upon by Swedish healthcare firms for internal decisions and be a contribution in realizing what kind of effects IC has on firms, in addition to being able to precisely locate and understand which aspect of IC affects their financial performance, and productivity. In addition, the result contributes in understanding the general market perception in Sweden and potentially shows that Sweden may yet require more time in enhancing the general awareness and recognition of the importance of IC.

Limitations to the thesis mainly concerned with the sample, namely the fact that a number of firms within the healthcare sector were founded mid-duration of the studied time frame and some were heavily focused on research and development with limited operations, resulting in a weaker relationship between IC and firm performance. In addition, some control variables were not found to have any relationship with the explanatory variables, showing that different or additional control variables might be able to present a more accurate relationship. Further research could be performed within a shorter timeframe and focus on a different industry or a more specific sub-sector that encompasses firms that all have fully functioning operations during the timeframe. Finally, future studies could be performed in different contexts such as varying countries and industries that have not yet been examined in the existing literature to investigate the context specific relationship.

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Appendix

Pairwise correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) ROA	1.000												
(2) ROE	0.751	1.000											
(3) MB	-0.176	-0.341	1.000										
(4) DE	-0.044	-0.249	0.207	1.000									
(5) FirmAge	0.206	0.107	-0.019	0.070	1.000								
(6) HCE	0.120	0.035	-0.015	-0.021	0.130	1.000							
(7) CEE	0.023	-0.020	0.042	-0.078	0.062	0.109	1.000						
(8) RDE	0.035	-0.076	0.023	0.046	0.035	0.021	0.004	1.000					
(9) RCE	0.093	0.040	-0.084	0.079	0.122	0.037	0.029	0.017	1.000				
(10) SCE	-0.059	0.014	0.009	-0.038	-0.017	-0.015	-0.011	-0.841	-0.013	1.000			
(11) VAIC	0.101	0.035	-0.069	0.043	0.153	0.309	0.249	-0.147	0.905	0.230	1.000		
(12) LTA	0.433	0.275	-0.210	-0.027	0.489	0.197	0.110	0.020	0.271	-0.042	0.302	1.000	
(13) ATO	0.363	0.183	-0.022	0.083	0.023	0.041	0.048	0.039	0.103	-0.040	0.103	0.068	1.000

Table 5: Pearson Correlation Matrix

VARIABLES	(1) ROA	(2) ROE	(3) ATO	(4) MB
VAIC	-0.0290	-0.0784	0.00144	0.000549
	(0.0547)	(0.209)	(0.000939)	(0.00436)
LTA	8.230***	15.70***	0.0129	-0.852***
	(1.750)	(4.675)	(0.0264)	(0.298)
DE	-0.710	-15.03**	0.0230	
	(1.101)	(7.093)	(0.0200)	
FirmAge				0.0342
				(0.0340)
Constant	-61.83***	-112.1***	0.506**	9.964***
	(12.23)	(30.40)	(0.216)	(1.582)
Observations	460	460	460	378
R-squared	0.219	0.199	0.019	0.056

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: OLS regression with clustered standard errors on firmid for VAIC^{TM}.

VARIABLES	(1) ROA	(2) ROE	(3) ATO	(4) MB
HCE	0.183	0.0192	0.00173	-0.00136
	(0.179)	(0.357)	(0.00355)	(0.0226)
CEE	-0.124	-0.798	0.00373	0.0560*
	(0.119)	(0.590)	(0.00528)	(0.0313)
RDE	-0.158	-3.477***	0.00181	0.184***
	(1.616)	(0.707)	(0.0134)	(0.0663)
RCE	-0.0261	-0.0133	0.00158	-0.00192
	(0.0613)	(0.225)	(0.00116)	(0.00499)
SCE	-0.190	-1.141***	-0.000960	0.0490***
	(0.408)	(0.240)	(0.00462)	(0.0181)
LTA	8.029***	15.49***	0.0106	-0.829***
	(1.793)	(4.748)	(0.0268)	(0.301)
DE	-0.748	-15.18**	0.0228	
	(1.111)	(7.162)	(0.0206)	
FirmAge				0.0318
				(0.0340)
Constant	-60.85***	-111.0***	0.521**	9.871***
	(12.42)	(30.59)	(0.221)	(1.608)
Observations	460	460	460	378
R-squared	0.224	0.210	0.022	0.061

Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 7: OLS regression with clustered standard errors on firmid for individual components of VAIC^{TM}.