Portfolio forming decisions: the role of intellectual capital

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Abstract

Purpose – The purpose of this paper is to present a tool to categorize companies as potentially profitable on the basis of an intellectual capital (IC) analysis.

Design/methodology/approach – The paper distinguishes two crucial attributions for picking shares: IC and capitalization of IC-based growth potential. Using these two attributions, the author creates a portfolio from a sample of European companies and annually rebalances it. To test its attractiveness, the author then compares the portfolio with benchmarks and random portfolios during the period from 2006 to 2013 using a Sharpe coefficient.

Findings – The comparison of the constructed portfolio with the benchmarks demonstrates the importance of IC for market investors and the validity of the proposed tool. The Sharpe ratio of the portfolio is significantly higher than the mean and median Sharpe ratios of random portfolios. In addition, the importance of IC for choosing proper investment goal increases in crisis.

Research limitations/implications – This investigation can be improved by analysing other IC such as the qualification of CEOs, participation of the company in business alliances, and a company's innovation activity. In addition, the paper considers only European companies.

Practical implications – The proposed tool provides a method to construct investment-attractive portfolios on the basis of IC.

Originality/value – The paper contributes to the literature by identifying the underestimated shares on the basis of a company's IC and by developing an algorithm to create an IC-based investment portfolio.

Keywords Growth, Intellectual capital, Portfolio comparisons, Sharpe coefficient

Paper type Research paper

1. Introduction

The idea of forming an investment portfolio on the basis of fundamental factors has been thoroughly investigated. However, the knowledge economy has helped to identify new value drivers that are intangible by nature. Therefore, investment attractiveness lies in the influence of both tangible and intangible internal factors as well as external factors. Although the literature broadly discusses the creation of a portfolio using intellectual capital (IC), no consensus exists on method.

Recent research dedicated to IC and capital markets concentrates on the influence of particular types of IC such as research and development (R&D) expenditure, R&D stock, market capitalization, market value, or market return. Griliches (1981) reports that market investors recognize high R&D expenditure as an influential trigger for the growth of future earnings and returns on shares. Daniel and Titman (2006), Chan *et al.* (2001), and Lev and Sougiannis (1999) empirically show that IC influences market indicators and offer different explanations for this phenomenon. Some studies use portfolio comparisons to show influence (Lev and Sougiannis, 1999; Chan *et al.*, 2001; Anagnostopoulou and Levis, 2008). However, most papers attempt to find evidence of IC recognition based on the stock market or discuss whether indicators of IC are useful to investors. Unfortunately, the lack of relevant strategies prevents investors from categorizing companies as potentially

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profitable on the basis of an analysis of IC. This paper fills this gap in the literature by providing a distinctive tool to categorize companies as potentially profitable on the basis of an IC analysis. The author creates a portfolio of investment-worthy companies by means of two crucial attributes for picking shares: IC and the capitalization of IC-based growth potential in market indicators. Although many papers examine IC, most ignore the capitalization of IC-based growth potential in market indicators, which seems to be very important. A company with a high IC value but low market capitalization is undervalued by the stock market and therefore attractive for investors. Alternatively, a company may have a high value of IC, but if this value has already been capitalized in the share price, the time for investing in this company has passed. This study uses the market-to-book (M/B) coefficient to determine firms' growth potential following the findings of Chan *et al.* (2001), Zeghal and Maaloul (2010), Orens *et al.* (2009), and Youndt *et al.* (2004).

The remainder of this paper is structured as follows: Section 2 reviews the literature on the recognition of IC by the stock market. Section 3 describes the tool used to pick companies on the basis of IC. Section 4 provides the samples and subsamples used for the empirical testing. Section 5 presents the main findings and, specifically, the portfolio comparisons results. Section 6 concludes with a summary of the main results, a discussion, and future research suggestions.

2. Literature review

The literature review is divided into two research areas: capital markets and the analysis of IC. All papers discussed attempt to discover the influence of IC on market performance. However, the papers that analyse the problem from a capital market perspective usually concentrate on market performance measures and techniques. Indeed, they refer to IC as just another determinant of return or market capitalization and do not analyse them in depth. Conversely, papers dedicated to IC recognize market performance as one of the possible outcomes and stress the nature, variety, and measurement of IC. This paper considers both points of view.

2.1 IC

IC has a vague nature and heterogeneous structure. Therefore, the literature offers no single definition (Clarke *et al.*, 2011). It is usually interpreted according to the research purpose. This study follows Kristandl and Bontis (2007, p. 1518) who define IC as the "strategic firm resources that enable an organization to create sustainable value, but are not available to a large number of firms". Accounting literature describes resources that are nonphysical and nonfinancial and usually not included in financial statements as intangible assets. According to IFRS and US GAAP, intangible assets are nonmonetary assets without physical substance. Both standards require the possibility of future economic benefits and costs that can be reliably measured to recognize assets as intangible. This paper ascribes a broader meaning than intangible assets to IC because IC includes both intangible assets and assets for which it is impossible to measure benefits and costs, such as relationships with customers and employee knowledge and qualification. For example, patent value and goodwill are only included in financial statements if they meet the requirements of accounting standards (Guthrie and Petty, 2000). Therefore, financial reports do not contain all IC components that may influence a company's performance.

Market indicators are often regarded as an outcome of IC. The most popular indicators are market value, Tobin's q, and M/B ratio. Research usually measures IC using a set of proxy indicators. However, some papers use specially developed

indicators such as the value added intellectual coefficient (Pulic, 2000; Chen *et al.*, 2005; Chan, 2009; Maditinos *et al.*, 2011) or the calculated intangible value.

Research on developed markets shows that IC plays an important and statistically significant role in a company's market valuation. Nold (2012) uses a matched sample comparison group approach for US companies to show that IC improves the probability of a company to outperform similar companies. Orens *et al.* (2009) study 267 European companies and find that the disclosure of IC is positively associated with Tobin's *q*. Zeghal and Maaloul (2010) show the association between IC and stock market performance is only significant for high-tech UK industries.

Research on developing countries does not reveal a strong influence of IC on market performance. These results are usually debatable. Chan (2009) and Garanina (2009) argue that IC is not a key driver of market performance on developing markets for several reasons including problems in their disclosure and a large number of noise traders.

Prior literature confirms that voluntary disclosures provide valuable information to investors (Miller *et al.*, 2013). Empirical papers find that IC disclosure can positively influence market value (Orens *et al.*, 2009) and stock liquidity (Healy *et al.*, 1999) and decrease costs of capital (Orens *et al.*, 2009) and information asymmetry (Abdolmohammadi, 2005; Miller *et al.*, 2013; Garanina and Dumay, 2014). That is, IC disclosure reduces the misevaluation of companies' stock prices (Abdolmohammadi, 2005) and moves market capitalization closer to fair value. These advantages are explained by the ability of IC disclosure to represent long-term perspectives of a company development, inform external investors about strategic resources, and build trustworthiness (Garanina and Dumay, 2014).

Practitioners also recognize IC components and their disclosure as important factors for making investment decisions. Abdolmohammadi (2005) notes that some SEC commissioners' comments on the Fair Disclosure Regulation [1] underline the importance of IC voluntary disclosure. Although the information of financial reports is commonly available and standardized, investors may be interested in more sophisticated factors that have intangible nature (Abhayawansa and Abeysekera, 2009). For example, Holland (1996) finds that portfolio managers regard information about relationship capital – in particular, relationships with customers and suppliers, brand loyalty, image and reputation, trademarks, and distribution channels – as the most useful determinants for decision making. He argues that these IC components are resources able to create stable competitive advantages and influence market capitalization.

Despite the benefits of disclosure, few companies voluntarily disclose IC in their annual reports (Guthrie and Petty, 2000; Bontis, 2003; Abdolmohammadi, 2005). When reported, the information is usually qualitative and cannot be easily transformed into quantitative metrics to be implemented in any kind of statistical analysis, particularly for portfolio construction. Lee and Guthrie (2010) use content analysis to show that portfolio managers recognize the importance of IC; however, its disclosure in company's reports and on web pages needs to be developed.

2.2 Capital markets

The majority of studies related to capital markets concentrate on R&D expenses. Lev and Sougiannis (1999), Chan *et al.* (2001), Hirschey and Richardson (2004), Eberhart *et al.* (2004), Anagnostopoulou and Levis (2008), and Duci *et al.* (2011) use the value of R&D expenses, stock of R&D, and R&D intensity to explain market indicators. The findings reveal that R&D expenses are usually positively recognized by the stock market.

Few studies concentrate on the other indicators of IC. Chan *et al.* (2001) analyse advertising expenses as a part of the company's IC, which influence share returns. Fan and Case (2010) investigate the impact of R&D and advertising expenses on future first, second, and third year buy-and-hold returns. Hirschey and Richardson (2004) extend the analysis by including the quantity and quality of patents as a measure of research activity. Kallapur and Kwan (2004) examine brand and contracting incentives as determinants of market capitalization and abnormal returns. Daniel and Titman (2006) investigate the impact of intangible information measured as the part of past returns unexplained by tangible information about past performance on monthly returns. Jagannathan and Wang (1996) modify the capital asset pricing model to include human capital. They demonstrate that, in contrast to classic capital asset pricing, the modified model that includes human capital explains the cross-sectional differences in average return. However, the other components of company's IC are ignored in capital market research.

Portfolio comparisons are often used in this kind of research. Chan *et al.* (2001) form six portfolios, from low to high R&D value plus a non-R&D portfolio. Fan and Case (2010) divide sample in ten portfolios according to companies R&D to market value ratio. Lev and Sougiannis (1999) rank sample companies by book-to-market value and form ten portfolios. Daniel and Titman (2006), Al-Horani *et al.* (2003), and Anagnostopoulou and Levis (2008) use similar methodology. In contrast, this research uses portfolio comparisons to investigate the influence of IC (usually R&D) on excess return, market value, and capitalization. Existing papers rarely relate revealed dependence to portfolio construction and management.

Despite the findings about the connection between IC and market value, the influence of IC (both disclosed by a company and evaluated by external agencies and experts) on company's shares returns is still unclear. High market capitalization does not imply high rates of growth. Researchers connect IC disclosure with the reduction of informational asymmetry and, therefore, with market efficiency. But whether markets are efficient enough to capitalize all disclosed information about IC and how many times a market needs to capitalize it are unclear. The author assumes that IC allows investors to recognize potentially profitable companies before their growth.

3. Research design

According to the previous research, IC is regarded by investors as a source of competitive advantage and therefore provokes growth in market capitalization. Investors seek undervalued companies; however, growth potential determined by IC can be previously recognized by the market and capitalized into share prices. Therefore, a company is attractive only if it has a high quality and quantity of IC and the market undervalues it. Consequently, the methodology must necessarily identify and measure how much a company is undervalued.

The literature shows that the M/B ratio determines the effectiveness of IC implementation. To pick investments, prior studies often use the same coefficients (M/B ratio) or inverse coefficients (B/M ratio; e.g. Goyal and Welch 2008; Lewellen 2004; Campbell and Thompson, 2008). Fama and French (1992), who lay the foundation for the role of B/M ratio in finance, show that the B/M ratio explains cross-sectional variation in stock returns. In addition, growing body of literature verifies the relation between the B/M ratio and stock returns. For example, both Kothari and Shanken (1997) and Pontiff and Schall (1998) find support for the same hypothesis: B/M of the Dow-Jones Industrial Average predicts market return. Fama and French (1998) demonstrate that stocks that are characterized by a high B/M ratio have higher returns in the future. They also find

evidence for this hypothesis in different capital markets. Johnson and Soenen (2003) analyse the B/M influence on the other performance indicators. They show that companies with a high B/M ratio have a higher Jensen's alpha, a higher share of economic value added in material assets, and a lower Sharpe coefficient. However, most relevant papers show that the M/B coefficient relates negatively to future returns.

As a result, this paper defines two attributions as particularly important for picking shares: IC and a low M/B ratio. The first is vital to determine market value growth potential, and the second checks whether the potential has been realized. Both are essential to portfolio forming decision making on the basis of IC and allow investors to avoid picking overvalued or fairly valued shares. Table I and Figure 1 provide an overview of the research framework.

The framework of the research has three stages:

(1) Determining the intellectual drivers of value: although each company has a wide range of IC components, this study focuses on the basic types that are significant for value creation. The literature dedicated to value creation and IC was analysed to identify those factors and validate them. All chosen value drivers should be available to market investors.

(2) Portfolio formation: in the first step of portfolio formation, the market capitalization growth potential explained by company IC is determined. However, the measurement of IC and its outcomes is complicated. Therefore, this study does not attempt to measure value growth potential. Instead, companies that have higher value growth potential than the average company (given a chosen set of companies) are determined. The median of intellectual value driver X is used to divide companies into two groups: those with relatively high growth potential based on X and those with relatively low growth potential based on X. In other words, the chosen set of companies is

	M/B	
IC drivers	Low	High
Low	Fairly estimated	Overestimated
High	Underestimated	Fairly estimated

Table I.
Portfolio forming decisions

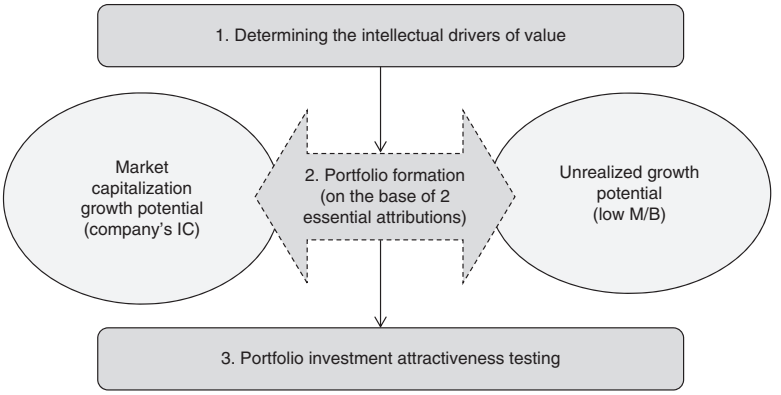

Figure 1.
The framework of the research design

filtered, and the number of IC-based filters is equal to the chosen value drivers. The use of median instead of mean eliminates the influence of outliers. In practice, other statistical measures such as quantile can be used to choose companies with IC-based growth potential.

In the second step of portfolio formation, companies with unrealized growth potential are chosen. This study uses the median M/B indicator to divide companies into two groups: those with relatively unrealized growth potential and those with relatively realized growth potential. This M/B filter is implemented after the IC-based filters. The final set of companies is used to form a portfolio. Given that the choice of weights is debatable, this study uses equal weights for shares, following Chan *et al.* (2001) and Al-Horani *et al.* (2003).

(3) Portfolio investment attractiveness testing: to prove its investment attractiveness, the portfolio is tested using a Sharpe coefficient analysis, comparisons with benchmarks, and confidence interval construction. Sharpe (1966) develops the coefficient to measure portfolio return weighted by risk. As a measure of risk, Sharpe suggests using the volatility of portfolio calculated by standard deviation. The Sharpe coefficient is defined as:

$$S = \frac{E(r - r_f)}{\sqrt{Var(r - r_f)}} \tag{1}$$

where r is the return of portfolio calculated using daily returns of shares; r_f the return of alternative investments (risk-free return calculated as the return of the US treasury bills converted from dollars to euros using interest rate parity); $E(r–r_f)$ the average daily return of the portfolio for the period of time, calculated as the cumulative return for the period is divided by the square root of the number of days; and *Var* the dispersion of the portfolio's daily returns.

Two benchmarks for portfolio comparisons are used:

- MSCI Europe index: MSCI Europe is a free float-adjusted market capitalization weighted index of large- and medium-sized European companies. The index, developed by Morgan Stanley Capital International, covers about 85 per cent of free float-adjusted market capitalization for Europe's developed equity markets. Investment in indexes is usually regarded as a risk-avoiding strategy because it can capture market average return and decrease the volatility of separate shares. MSCI Europe benchmarks IC-based portfolio with the market average.
- MB portfolio: the M/B portfolio is a set of companies with relatively unrealized growth potential based on their M/B ratio and low growth potential based on IC. The comparisons of the MSCI Europe index portfolio with the MB portfolio prove the importance of IC for investment attractiveness.

4. Sample and method

The author investigates this framework based on a sample of European companies from, namely, Great Britain, Germany, France, Italy, and Spain. The chosen countries have developed financial markets and an aggregate GDP that makes up 71 per cent of European Union's GDP. The development of the knowledge economy in these countries is

taken into account with the help of two composite indexes calculated by World Bank: the knowledge index (KI) and the knowledge economy index (KEI). All sample countries are in the first quartiles of KI- and KEI-based country ratings. This study supposes that institutional innovativeness allows investors to recognize intellectual value drivers more easily. Each sample company is a public company so that information is available to internal investors.

The sample is formed from databases such as Amadeus (Bureau Van Dijk), QPAT, and Datamonitor as well as company sites and other sources. The implementation of the criteria (country affiliation and data availability) forms a sample of 1,696 companies. Using the period from 2004 to 2011, the sample consists of 13,568 observations with 44 per cent of observations related to British companies, 25 per cent to French, 24 per cent to German, 5 per cent to Spanish, and 2 per cent to Italian.

To implement the proposed method of portfolio formation, the value drivers with an intangible nature are determined. All the various definitions and decompositions underline IC heterogeneity and the lack of a generally accepted measurement method. That is, the nature of IC determines the complication of quantitative valuation. Therefore, IC quantity and quality can be expressed only by approximate indicators. Table II outlines the proxy indicators.

This study begins with six indicators of IC quantity and quality:

(1) Labour force qualification: the human capital of a company consists of employee knowledge, skills, and experience. However human capital cannot be measured for each employee on the base of publicly available information. Therefore, the qualifications of top management are measured. These qualifications are expected to play a significant role in knowledge and value creation and to be positively correlated with employee human capital. Shrader and Siegel (2007) and Ugboro and Obeng (2000) also investigate this assumption.

(2) Labour productivity: revenue and earnings are usually regarded as one of the main results of human capital implementation (Backhuijs *et al.*, 1999; Johanson *et al.*, 1999; Miller *et al.*, 1999). Thus, earnings per employee are used to evaluate the average efficiency and productivity of human capital.

(3) Computer resources and infrastructure: computer resources and information technology implementation can lead to value creation. Although every company now uses IT in varying degrees, some outstanding computer-related value drivers can be recognized, which help to range companies. Previous research use expenditure on computers, IT, and software (Mouritsen, 2003; Diez *et al.*, 2010); however, this information is not available to market investors. Therefore, this paper analyses enterprise resource planning (ERP) systems. ERP systems are based on IT and integrate company activity and manage assets and human resources, finance, and quality. As a result, these systems transform intangible assets into value.

(4) R&D intensity: as previously noted, R&D expenses are positively recognized by capital markets. R&D-related activity can be regarded as the creation of new knowledge and therefore as investment in IC.

(5) The number of patents: the more R&D results a company has, the more innovative it is and, therefore, the higher the value growth potential is. Although the value created by patents is more important than the number of patents, the number is available to the market investors.

Table II.
Proxy indicators of intellectual capital

IC value driver		Labour force qualification	Labour productivity	Computer resources and infrastructure	R&D intensity	Number of patents	Advertising expenses	Ownership
Proxy indicator		Board of directors' qualification	Earnings per employee	ERP systems implementation	R&D intensity	Number of patents	Advertising expenses	Foreign capital employed
Papers that use the same or similar proxy	Intellectual capital research	Sullivan (2000), Edvinsson and Malone (1997), Roos and Roos (1997)	Huang and Wang (2008), Sveiby (1999), Memorandum of The Danish Trade and Industry Development Council (DTI) (1998); Molodchik *et al.* (2012)	Mouritsen (2003), Diez *et al.* (2010), Garanina (2009), Edvinsson and Malone (1997)	Diez *et al.* (2010), Mouritsen (2003), Sveiby (2001), Baiburina and Golovko (2008), Edvinsson and Malone (1997)	DTI (1998), Sullivan (2000), Edvinsson and Malone (1997), Roos and Roos (1997)	Mouritsen (2003), Garanina (2009)	Mohd *et al.* (2009), Orens *et al.* (2009)
	Value drivers research	Roper *et al.* (2008)	Roper *et al.* (2008)	Doern and Fey (2006), Ruivo *et al.* (2014)	Lev and Sougiannis (1999), Chan *et al.* (2001), Daniel and Titman (2006), Anagnostopoulou and Levis (2008)	Coombs and Bierly (2006), Greenhalgh and Longland (2005)	Johnson and Soenen (2003), Lev and Sougiannis (1999)	Yoshikawa and Gedajlovic (2002)
Method of estimation		Company's Annual Report, section "Directors' information" If more than one-third of directors have postgraduate level qualifications and more than five years' experience – 2 points. If more than one-third of directors have postgraduate level qualifications or more than five years' experience – 1 point Otherwise – 0	Company's Annual Report, section "Financial data" Earnings before interests and taxes (EBIT) divided by number of employees	Search on company's website using the following words: "ERP", "Oracle", "NAVISION", "NAV", "SQL", "SAP" If company has news about these as listed above – 1 point, otherwise – 0 points	Company's Annual Report, section "Financial data" Share of R&D expenses in company's earnings	The number of company patents according to the patents database QPAT	Company's Annual Report, section "Financial data" Advertising expenses	Company's Annual Report, section "Shareholders" If a company has foreign investors – 1 point, otherwise – 0 points

(6) Advertising expenses: the purpose of advertising is to attract new customers and make the company's name more easily recognized. Therefore, advertising expenses are an investment in relationships with customers and potentially lead to value creation. However, only about 5 per cent of the sample companies report their advertising expenses. To maintain the sample size, this indicator is excluded from the analysis.

(7) Ownership: following Mohd *et al.* (2009), this study assumes that foreign capital identifies a company's popularity, attractiveness, and recognition in foreign markets.

Much research (e.g. Doern and Fey, 2006; Roper *et al.*, 2008) concentrates on environmental characteristics as a value driver. Therefore, the innovation-related subindex of Global Competitiveness Index is used to control for environmental innovativeness[2]. Table III presents the sample descriptive statistics. Each year is analysed independently.

Because some of these indicators change quarterly or annually, the author rebalances the portfolio annually. Following Duci *et al.* (2011), the rebalance is done in the middle of the year to control for the time of company reporting. Duci *et al.* argue that this methodology guarantees the availability of financial statements for market investors. However different companies report at different times; therefore, investors at a given moment have different information about sample companies.

Sharpe coefficients of the IC-based portfolio and chosen benchmarks are analysed by a daily expanding window. Sharpe coefficients are compared every day to determine the most attractive portfolio. An expanding window determines that the Sharpe ratio comparisons of the same portfolio at different periods of time are impossible.

5. Results

5.1 Portfolio formation

Using the M/B data and the value drivers, the set of companies in which to invest are chosen (IC-based portfolio). The companies with low M/B ratio and low value of IC (M/B portfolio) are also chosen for benchmarking. Table IV provides the results.

The majority of the companies included in the IC-based portfolio in Table IV are German and the remainder are British. Only the portfolio formed on the basis of 2008 data contains one French company. Conversely, the M/B portfolio has companies from all five countries. Further equal-weighted portfolios are constructed annually. To evaluate the returns and Sharpe coefficients, the sample is supplemented with daily share price data from the Bloomberg database. The time period analysed is from 1 July 2005 to 30 June 2013.

5.2 Portfolio returns

Figure 2 shows the portfolios returns. The results show that IC improves investors' ability to pick the most profitable companies compared to the benchmarks. The portfolio performs better in the pre-crisis period, has lower drawdown during the crisis, and recovers faster afterwards. However, due to high volatility, the Sharpe ratios are analysed.

5.3 Sharpe ratios

The analysis starts on 1 January 2006, to collect enough data for standard deviation calculation. Figure 3 presents the dynamics of the Sharpe ratios. Table V reports the value of the Sharpe coefficients of the IC portfolio and the benchmarks before annual rebalancing. The analysis shows that the IC-based portfolio contains the most attractive companies in terms of return and risk-adjusted return. The M/B portfolio has

		Board of directors' qualification	Earnings per employee (th.euros)	ERP systems implementation	R&D intensity	Number of patents	Foreign capital employed	GCI innovation-related sub-index	M/B value
2004									
	Mean	1.24	0.07	0.29	−24.7	241	0.88	4.83	5.76
	Median	1	0.01	0	0.04	0	1	4.78	1.25
	SD	0.71	1.18	0.45	599.20	2650.50	0.32	0.43	85.29
2005									
	Mean	1.25	0.13	0.29	0.75	243.81	0.88	4.83	7.87
	Median	1.00	0.01	0.00	0.04	0.00	1.00	4.78	1.44
	SD	0.71	1.65	0.45	8.77	2 687.23	0.32	0.43	115.53
2006									
	Mean	1.25	0.12	0.30	−0.10	255.76	0.89	4.83	9.79
	Median	1.00	0.01	0.00	0.05	0.00	1.00	4.78	1.53
	SD	0.71	0.95	0.46	6.69	2 749.35	0.32	0.43	171.64
2007									
	Mean	1.25	0.57	0.30	−0.08	267.85	0.89	4.83	5.55
	Median	1.00	0.01	0.00	0.06	0.00	1.00	4.79	1.39
	SD	0.71	14.66	0.46	27.89	2 814.84	0.32	0.47	65.20
2008									
	Mean	1.26	−0.16	0.31	0.25	279.69	0.89	4.71	2.91
	Median	1.00	0.01	0.00	0.05	0.00	1.00	4.66	0.96
	SD	0.71	4.76	0.46	4.38	2 874.11	0.31	0.41	32.26
2009									
	Mean	1.26	0.05	0.32	0.20	291.32	0.89	4.61	4.03
	Median	1.00	0.01	0.00	0.03	0.00	1.00	4.60	1.11
	SD	0.71	1.50	0.47	10.24	2 930.99	0.31	0.39	37.60
2010									
	Mean	1.27	0.16	0.33	0.24	302.15	0.89	4.64	6.98
	Median	1.00	0.01	0.00	0.07	0.00	1.00	4.65	1.21
	SD	0.71	1.21	0.47	2.73	2 986.85	0.31	0.43	84.09
2011									
	Mean	1.26	0.15	0.34	0.30	312.00	0.89	4.89	8.62
	Median	1.00	0.01	0.00	0.08	0.00	1.00	4.94	1.08
	SD	0.71	1.24	0.47	8.69	3 046.24	0.31	0.45	172.33

Table III.
The sample descriptive statistics

Year	Number of companies: IC-based portfolio	MB portfolio
2004	15	128
2005	28	30
2006	25	28
2007	22	24
2008	30	25
2009	20	30
2010	20	34
2011	19	24

Table IV.
The chosen sets of companies

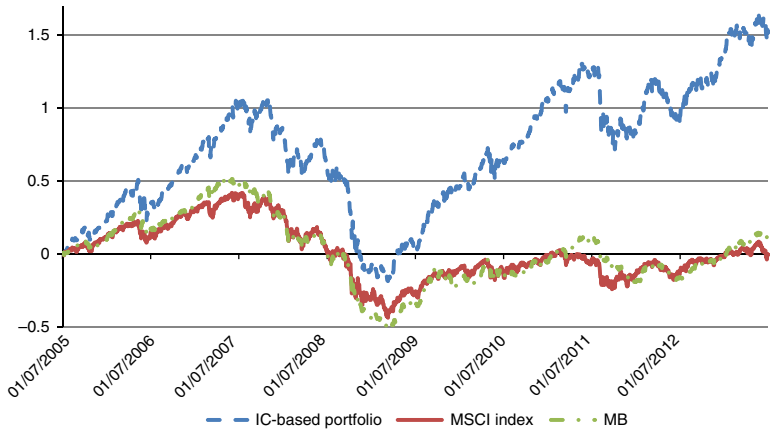

Figure 2.
The returns of IC-based portfolio and benchmarks

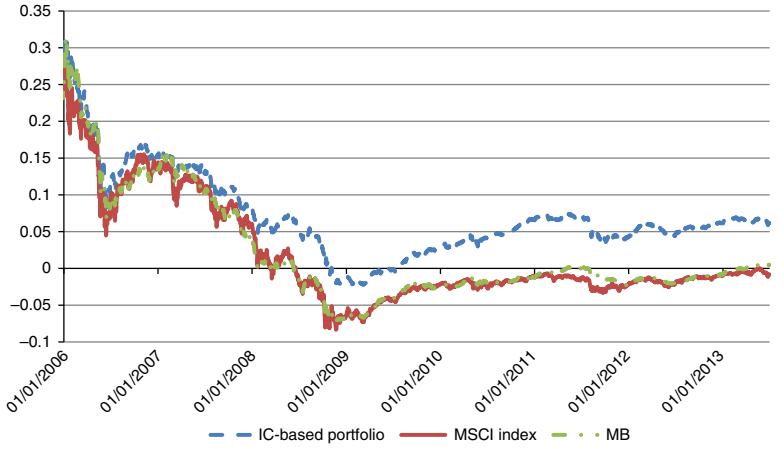

Figure 3.
The Sharpe ratios of IC-based portfolio and benchmarks

Date	30/06/2006	30/06/2007	30/06/2008	30/06/2009	30/06/2010	30/06/2011	30/06/2012	30/06/2013
Returns								
IC-based portfolio	0.3367	1.0058	0.5931	0.0747	0.6376	1.235	0.9467	1.5142
MSCI index	0.1416	0.3943	0.0277	−0.2712	−0.1429	−0.0436	−0.1186	−0.0079
MB portfolio	0.1702	0.4696	0.0123	−0.34	−0.1439	0.1003	−0.1646	0.1350
Sharpe coefficients								
IC-based portfolio	0.1225	0.1299	0.0530	−0.0011	0.0401	0.0675	0.0459	0.0614
MSCI index	0.0971	0.1088	−0.0142	−0.0425	−0.0249	−0.0132	−0.0195	−0.0085
MB portfolio	0.0927	0.1036	−0.0141	−0.0399	−0.0199	0.0014	−0.0197	0.0046

Table V.
The Sharpe ratios of IC-based portfolio and benchmarks at the chosen date

results that are close to the index or slightly better. Thus, the findings underline the crucial role of IC in portfolio formation.

The Sharpe ratios of the portfolio and the benchmarks are also analysed daily to choose a leader. The leading portfolio is characterized by the highest Sharpe ratio

(between the IC-based portfolio and the benchmarks). Both the absolute values and 95 per cent confidence intervals of the Sharpe ratios are analysed. If the lower confidence interval of the IC-based portfolio is higher than the upper confidence interval of MSCI Europe index or upper confidence interval of MB portfolio at the same period of time, it is the leader at a 5 per cent level of significance.

Table VI shows the percentage of days in which the portfolio leads. Both the whole period (1 July 2005-30 June 2013) and the crisis period (1 January 2008-31 December 2009) are analysed because some relations between IC and market value that existed before the crisis can be unstable to exogenous shocks. The results show the continuing attractiveness of the IC-based portfolio: It is the leader throughout the crisis and recovery periods. This finding supports the idea that a company's IC is of great importance during an economic recession.

5.4 Comparisons with random portfolios

Although the IC-based portfolio is compared with the benchmarks using an analysis of risk-adjusted return and confidence intervals, some additional verification should be conducted. To check the robustness of results, the portfolio is compared with a number of random portfolios. This procedure checks whether the high returns and the Sharpe coefficients of the IC-based portfolio are non-random and can be explained by company IC.

Each random portfolio includes 20 randomly selected shares of companies from the whole sample of 1,696 companies. The number of shares is chosen as the median value of shares in the IC-based portfolio. The random portfolio is equal-weighted and rebalanced annually in the middle of year. After each simulation the random portfolio leadership over the benchmarks and the IC-based portfolio (on the basis of Sharpe coefficients) is evaluated. The mean and median values, maximum and minimum of the leader percentages are evaluated after 100 simulations. Table VII reports the results.

The results indicate that, on average, the random portfolios lead the benchmarks by 53.62 per cent (64.95 per cent in absolute terms) of the analysed interval. The median value of the leader is slightly higher at 64.37 per cent (74.99 per cent in absolute terms). While a steady leader is absent, investing in random portfolios is not preferable in comparison with the benchmarks. The comparisons with the IC-based portfolio show that random portfolios have less value of risk-adjusted return during the larger part of

Table VI.
The results of statistical portfolio comparisons

Leadership of IC-based portfolio, percentage	Absolute values (%)	5% level of significance (%)
01/07/2005-30/06/2013	96.09	91.21
Crisis period, 01/01/2008-31/12/2009	100	100

Table VII.
The results of random portfolios comparisons

	Comparisons with benchmarks		Comparisons with IC-based portfolio	
	Absolute values (%)	5% level of significance (%)	Absolute values (%)	5% level of significance (%)
Mean	64.95	53.62	8.20	7.65
Median	74.99	64.37	5.15	4.34
Max	96.51	92.84	62.47	60.82
Min	3.84	0.52	0.03	0.00

the analysed time period: the average percentage of random portfolios leadership is 7.65 per cent (8.20 per cent in absolute terms); the median is 4.34 per cent (5.15 per cent in absolute terms).

6. Discussion

The literature exploring the influence of IC on market returns is limited as it takes into account only one component of IC, usually human capital, R&D expenses or advertising expenses. While IC is heterogeneous it is believed that a simultaneous analysis of several components allows better identification of profitable companies. More important, the growth of market value is possible only if the market has not capitalized the information about IC. Investments in IC are usually not transparent and sometimes even not reported, so the market needs to wait for the output of these investments to get any information. In other words it is believed that some market inefficiencies concerning IC exist. That is why the current paper presents a tool to categorize companies as potentially profitable on the basis of the analysis of IC.

The paper shows that a relatively low M/B value and a high value of IC characterize undervalued companies. The proposed tool was tested using a sample of European companies to recognize potentially profitable ones. To test the investment attractiveness the IC-based portfolio is compared with benchmarks and random portfolios. Portfolio comparisons show the ability and validity of the proposed method for picking investment goals. The IC-based portfolio demonstrates higher cumulative returns and Sharpe ratios than the benchmarks and random portfolios. It also confirms the existence of market inefficiencies concerning IC. The components of IC, which are not reported directly, reflect future earnings, value and growth with a time lag. That is why it is important to search for the components of IC that determine competitive advantages and invest in companies which have a high quantity and/or quality of those components before stock market acquires the information about them.

The current research extends the understanding of the role of IC during a crisis. The idea that company IC is of great importance during an economic recession is widespread. It is shown that in exogenous shocks, IC is not only significant for the survival of a company and its economic results, but also allows a lower drop in the market value and faster recovery. Whereas exogenous shocks influence all companies in the market, IC prevents a significant drop of company market value. The portfolio comparisons justify not only the increasing importance of IC for investors but also the ability of the proposed tool to choose between low valued companies which will grow in future, despite the fact that during the financial crisis the M/B ratios of the majority of companies drop.

7. Conclusions

This paper develops a tool that distinguishes two attributes important in identifying investment-worthy companies: IC and the capitalization of IC-based growth potential in market indicators. To determine the capitalization, the M/B ratio is adapted following Sveiby (1999), and Nold (2012). These study finds that companies that create or effectively use IC raise the M/B ratio and are, therefore, attractive to investors. Portfolio comparisons with benchmarks and random portfolios validate the proposed tool.

The results show that European financial markets are not efficient. Information on IC disclosed by companies allows investors to recognize potentially profitable companies. However, not all the investors recognize the importance of IC for company's performance.

This paper has some limitations. First, only some types of IC are analysed in the empirical testing of the proposed tool. IC is very heterogeneous and can be measured by

many different indicators. The selected proxies are not the only ones that can be used to identify potentially profitable companies. Second, IC indicators are chosen on the basis of literature analysis without any statistical verification. Third, the indicators are not analysed separately. Nonetheless, the author believes that the interaction between IC components can lead to synergetic effects that should be taken into account when making investment decisions. Also the paper ignores the probability of overinvestment in IC, when its high value is connected only with high expenditure that does not lead to the value growth of the company.

The findings are useful both for practitioners and researchers. The proposed tool allows market investors to categorize companies as potentially profitable on the basis of publicly available information about IC. In other words, it provides a kind of simple screening. Company management can apply the tool to diagnose the company's position in the stock markets and also to get some recommendation on IC disclosure. The results also can be used by researchers to develop empirical research on the market recognition of IC, to test and explain market inefficiency, and develop trading strategies.

Whereas the current research develops a tool to determine undervalued companies on the basis of IC, future development of this topic should provide a deeper analysis of IC. IC is heterogeneous and its components are evaluated and defined differently by different investors. Future work can also expand on this study by analysing the indicators separately. The selection of IC components can also be improved, for example, by implementing a regression analysis technique and using only those indicators that significantly influence a company's value.

Another possible research direction is connected with the development of investment strategies on the basis of IC. The rebalance of the IC-based portfolio is done annually in the middle of the year to guarantee the availability of financial statements for market investors. The Sharpe coefficient of the portfolio is higher than the Sharpe coefficients of benchmarks, and the study finds that the value growth potential is realized quickly. Nevertheless, finding the optimal frequency for portfolio rebalancing will increase the return of the portfolio and needs further research.

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Notes

1. Regulation Fair Disclosure is a regulation of the US Securities and Exchange Commission that lay all publicly traded companies under the obligation to disclose material information to all investors at the same time.
2. The Global Competitiveness Index is proposed and calculated by the World Economic Forum as a part of the annual Global Competitiveness Report.

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