Pricing Intellectual Capital in Asset Pricing Models: A study on Shanghai Stock Exchange

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Abstract

This study aims to examine the validity of intellectual capital as a priced risk factor in the asset pricing model. We have used the data of companies listed on the Shanghai Stock Exchange from 2000 to 2021. To test the models, time series as well as cross sectional analysis have been done using the Fama-MacBeth method. The results show that intellectual capital is a significant risk factor and after augmenting IC into asset pricing models improves the explanatory power to explain the variation in the stock returns. It further suggests that IC can be priced in the Chinese market, over and above what can be explained by covariance risk, size, value, investment and profitability factors.

Keywords: Intellectual capital; CAPM; Fama-French model; IC augmented model; Shanghai Stock Exchange.

JEL Classification: C1, G12

1. Introduction

` Over the last few years, several asset pricing models have been developed for relating the risks and returns in security markets. The first capital asset pricing model was formulated by Sharpe (1964) and Lintner (1965) which predicted asset return to be relative to beta, a measure of the risk of an asset compared to the market portfolio.

The key assumption for testing the asset pricing model is that the total stock market index can adequately represent the market portfolio. Despite it being widely used, Capital Asset Pricing Model was criticized by many researchers, including Fama and French (1992); Black (1972); and Fama and MacBeth (1973). The primary reason that beta is not the only significant systematic risk to capture variation in the cross-section returns (Silva et al., 2020). Roll (1977) challenged the model, arguing that the market portfolio return cannot be accurately measured by the stock market index return. Thus, in response to this criticism, researchers attempted to find other factors that can explain variations in the expected return premiums.

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The earnings-price ratio was found to have good explaining power for average return (Basu, 1977). Similar results were drawn by Rosenberg et al. (1985) for the book-to-market ratio, Bhandari (1988) for leverage and Banz (1981) for market capitalization. Fama and French (1992) introduced a model with three factors the market portfolio, size and value. Due to the shortcomings in the Fama-French three-factor model (FF3F) of not being able to completely capture variance in cross-section returns, two more factors were added: investment and profitability to form the Fama-French five-factor model (FF5F) in 2015. While several studies show FF5F to perform better than CAPM and FF3F; some research such as Fama and French (2017), Kubota and Takehara (2018) and Roy and Shijin (2019) found FF5F is not a successful model. Roy and Shijin (2018b) and Roy (2021) added another factor to the asset pricing model which was human capital and tested the model, finding it to outperform the older versions of the model.

Human capital is one of the components of intellectual capital (IC). Thus, IC is more comprehensive, which has been known as an important intangible asset that creates value for any firm (Xu et al., 2023; Sardo & Serrasqueiro, 2017). Hence, IC has been included as a factor in the asset pricing model by a few researchers. A study on the Egyptian Stock Exchange was conducted by Shahawy and Wahba (2021) that included components of IC in CAPM and they were found to be insignificant. While a research by Maharani and Narsa (2023) on the Indonesian stock market, added intellectual capital in asset pricing models; the findings showed intellectual capital to have a significant impact on the excess stock returns.

Chinese stock market, a prime example of an emerging market, is gradually maturing within the globalized economy. Despite being the second-largest stock market in the world, the factors influencing risk-premia on Chinese stocks are still not well understood. This uncertainty indicates that much remains to be uncovered about China's market's distinctive features and dynamics, especially regarding how risk is priced. As given in literature such as Weqar et al. (2020) and Xu and Liu (2021), intellectual capital is an essential resource of any firm and thus it can be considered a risk factor in the asset pricing model. Hence, this study will test the performance of intellectual capital factors in CAPM as well as in other multi-factor models including the Fama-French three-factor and five-factor model with theoretical justification in the Shanghai Stock Exchange.

Since the inclusion of intellectual capital as a factor in the asset pricing model is still not explored widely. Therefore, this study will further contribute to the literature on asset pricing. The empirical results from the study can help financial advisors assess market risks more effectively. Investors can thoroughly consider the intellectual capital as a factor, before making investment decisions.

In this study, first we will calculate the intellectual capital of the non-financial companies listed on the Shanghai Stock Exchange using the method given by Pulic (1998) known as

Value Added Intellectual Capital (VAIC) and then construct decile portfolios sorted on IC. The remainder of the study is organized as follows: Section 2 reviews existing literature on asset pricing models, while Section 3 details the methodology employed in this research. Section 4 presents the empirical results, and Section 5 offers the study's conclusion.

2. Literature Review

2.1 Asset Pricing Models

Asset pricing is an evolving field that has seen significant progress over time. The first major advancement was the Modern Portfolio Theory (MPT) introduced by Henry Markowitz in 1952 which stated that diversification allows an investor to select a portfolio that maximizes returns. This process consists of two phases: the first one involves past assessment of an asset, followed by forecasting its performance in the future. The second phase starts with estimating the assets' performance in the future and ends with the selection of the portfolio.

Markowitz's mean-variance rule posits that through diversification the risk can be reduced, although it cannot be entirely eliminated. An optimal portfolio is dependent on the covariance between the assets included in it (Pollet & Wilson, 2008). Thus, there is a trade-off between an asset's risk and its expected returns, requiring investors to select a portfolio that aligns with their risk-tolerance.

2.2 Capital Asset Pricing Model

Building on Markowitz's MPT, the conventional mean-variance capital asset pricing model (CAPM) was formulated by Sharpe (1964) and Lintner (1965). The model assumes that investors consider only the mean and variance of an asset's returns, consistent with MPT's assumption that systematic risk is the only risk that cannot be mitigated through diversification. Numerous studies have tested CAPM's validity in the stock market. One of the earliest was Black (1972), who validated CAPM by proving a linear relationship between expected returns and respective betas using data from the NYSE. Jensen et al. (1972) and Fama and MacBeth (1973) also supported CAPM's validity. However, Roll (1977) and Ross (1976) criticized the model, arguing that the market portfolio's proxy is inefficient because it does not contain all assets, making it an incomplete representation of the market portfolio.

2.3 Fama-French Three Factor Model

In response to CAPM's criticisms, researchers expanded the model by incorporating additional factors. Fama and French introduced a three-factor model (FF3F), adding two risk factors—size and value effects—besides market risk. They argued that an asset's return depends on three risk factors: market beta, the difference between small and large company stocks, and the difference between high and low book-to-market company stocks. Studies by Hassan and Javed (2011), Bhatti and Hanif (2010), Eraslan (2013), Rossi (2012) and Mirza (2008) found three-factor model superior to CAPM. Regardless of its success, the FF3F model faced criticism for lacking theoretic instinct for its size and value factor formation (Haugen & Baker, 1996; Griffin, 2002; Fama & French, 2012).

2.4 Fama-French Five Factor Model

In 2015, Fama and French added two more factors: investment and profitability to its previous model. Several studies on different equity markets have shown five factor model (FF5F) to perform better. Lin (2017) found that in the Chinese market, FF5F performed better than FF3F from 1997 to 2015 but the investment factor was found to be redundant. Similar results were found in the Chinese market by Huang (2019) from 1994 to 2016 and by Guo et al. (2017) from 1995 to 2014, but here a weak impact was found in the investment factor. Similarly, studies by Lohano and Kashif (2019) and Ali et al. (2019) on the Pakistani market also found FF5F to be better than previous models in finding the cross-sectional returns.

A study by Leite et al. (2018) was done on developing economies where four and five factor models outperformed three factor model but the inclusion of profitability and investment factor made the value factor irrelevant. Foye (2018) studied eighteen different emerging economies where FF5F performed better than FF3F; however, for Asian markets, the premiums of investment and profitability were not distinguishing enough.

2.5 Addition of human capital

Due to the issues with the FF5F model, researchers have continued to introduce new factors into asset pricing models. Roy and Shijin (2018a) developed and tested a multifactor equilibrium asset pricing model that included Fama-French factors, bond market factors, market portfolio, human capital, and momentum. They concluded that only the market portfolio and human capital were significantly priced factors in both emerging and developed markets. Maiti and Balakrishnan (2018) incorporated human capital as the sixth factor in the FF5F model. This enhanced model outperformed the CAPM, FF3F, and FF5F models, demonstrating that human capital is a significant factor in predicting stock returns of the Indian stock exchange. In another study, Roy and Shijin (2018b) included human capital in the asset pricing model and found the new augmented models to perform better than previous ones in explaining the variation in asset returns of listed firms of NYSE, NASDAQ and AMEX. Using the data from the Japanese market, Roy (2021) found that human capital is a significant risk factor in the asset pricing models. The studies on Pakistani market by Khan et al. (2023) and Thalassinos et al. (2023) concluded that the human capital-based asset pricing model performed better than previous models.

2.6 Addition of intellectual capital

Intellectual capital components were included in CAPM by Shahawy and Wahba (2021) using the dataset of firms listed on the Egyptian Stock Exchange from 2013 to 2018. Fama-MacBeth regression was used for cross section analysis. The results show that intellectual capital components are not significant and thus IC is not a suitable factor in the Egyptian market. In a study by Maharani and Narsa (2023) on Indonesian stock market from the year 2012 to 2022, intellectual capital was added to Fama French six factor model. IC factor was calculated using modified value added method. The GLS regression and GMM was used to test the models. The results showed intellectual capital to have a significant impact on the excess stock returns.

2.7 Research Gap and Contribution

Both the studies (Shahawy & Wahba, 2021; Maharani & Narsa, 2023) did not make investment portfolios. However, in this study we have made investment decile portfolios based on IC which are not made in any previous research. Additionally, we made a factor of IC using the methodology given by Moreno and Rodriguez (2009), Harvey and Siddique (2000), and Kostakis et al. (2012) which is different from the IC factor used in the previous studies. Therefore, these are the two contributions of our study on the Shanghai Stock Exchange. The findings of this study can assist financial advisors in more effectively assessing market risks.

2.8 Intellectual Capital

Intellectual capital (IC) is deemed as a strategic asset that boosts financial performance of business firms (Xu & Liu, 2021). Shih et al. (2011) described intellectual capital (IC) as the combined abilities and knowledge of all participants that contribute to creating competitive edge and generating wealth. Vishnu and Gupta (2014) characterized IC as wealth generated by utilization of knowledge. According to Soetanto and Liem (2019), IC is the knowledge useful in competition and creation of wealth.

Investors aim to accurately calculate returns of their investment. Researchers have developed methods for assessing investments and cash flow risks. IC plays a crucial role in determining a firm's performance, influencing its market value. Therefore, it is essential to consider IC when making investment decisions, as it is a significant source of competitive advantage and can enhance a firm's efficiency (Meles et al., 2016; Kehelwalatenna & Premaratne, 2014; Chang & Hsieh, 2011). If IC provides a competitive advantage, it should positively impact a firm's financial performance, making it a valuable investment.

Intellectual capital consists of structural capital, customer capital, and human capital, (Bayraktaroglu et al., 2019). Human capital includes an individual's talents, knowledge, capabilities and proficiency used to attain its goals (Medina et al., 2011; Weqar et al., 2020). It is highly valued as it is based on personal traits that is useful for the firm performance (Curado, 2008). Structural capital is the component of IC that is created by the human resource but remains within the company (Bontis et al., 2015). It consists of customs, processes, and values that support the knowledge produced by human resources and convert it into intellectual assets (Gates & Langevin, 2010). Customer capital includes the resources derived from individual and organizational networks (Ngah & Ibrahim, 2009; Ferreira & Martinez, 2011). It serves as a bridge between the firm and its various stakeholders including competitors, customers, communities and shareholders (Bozbura, 2004; Weqar et al., 2020).

Intellectual capital measurement methods are categorized into financial and non-financial valuation (Tan et al., 2008). Financial methods assess economic-value of intangible assets, enabling performance comparison with competitors. These methods include VAIC (Pulic, 1998), Tobin's Q (Luthy, 1998), and economic value added (Stewart, 1994). Non-financial methods identify the types, locations, and uniqueness of IC components within an organization. These include Intellectual-Capital Index (Roos et al., 1997) and Balanced Scorecard (Kaplan & Norton, 1992).

Among these methods, the value-added method is most widely used. Other methods often face issues of unavailable information, making external analysis difficult. However, VAIC calculations use data from publicly available financial reports (Clarke et al., 2011). VAIC allows for easy data retrieval, calculations, and firm comparisons due to its standardized measurement method (Maditinos et al., 2011).

In accordance to VAIC, IC comprises capital-employed efficiency, structural-capital efficiency, and human-capital efficiency (Pulic, 1998). Capital-employed efficiency measures how effectively financial capital is used by the firm, represented by the net assets' book value. Human-capital efficiency is the value generated from investing in employees, with salaries and wages often serving as proxies for human capital (Molodchik et al., 2012; Wang & Chang, 2005). Structural-capital includes delivery-networks, supply-chains, IT applications, and brands (Tan et al., 2008), and is calculated as the difference between human capital and value-added.

3. Research Methodology

3.1 Data and variables

Data for all the delisted and listed companies on the Shanghai Stock Exchange is taken from Thomson Reuters Eikon and DataStream and the financial report of the stock exchange listed firms of China from the period January 2000 to July 2021. To refrain from survivorship bias, delisted firms (dead and suspended/merged) are also included in the data sample. However, financial firms are excluded from analyzing the impact of cash and non-cash-based measures on the firms of non-financial sector.

To calculate stock returns, the prices of the firms for the period under study are required. The data was cleaned and required treatment for dead companies was done by assigning a stock return value of -1 for the month when company became dead; as suggested by Soares and Stark (2009). To calculate market return, data for all share index for the Shanghai Stock Exchange is taken. For calculation of excess returns, risk-free rate is required; a proxy of which is taken as SHIBOR (data is taken from Federal Reserve Economic Data).

The variables involved in making size, value, profitability and investment factors are Common Equity (WC03501), number of shares (NOSH), Total Assets (WC02999) and Earnings before tax (this was calculated by adding Net Income (WC01651) and Tax (WC01451)). For calculating the intellectual capital, data for the following variables was extracted: Earnings before interest and tax (WC18191), Depreciation (WC01148), Salaries and benefits expenses (WC01084) and Total Liabilities (WC03351). Data of all these variables are taken from Thomson Reuters Eikon and DataStream. The definitions of the variables are provided in Appendix A.

3.2 Estimation of Intellectual Capital

IC has been calculated using the model of Pulic (1998, 2000). According to studies i.e. (Shahawy & Wahba, 2021; Xu & Wang, 2018; Sardo & Serrasqueiro, 2017; Nimtrakoon, 2015; Vidyarthi, 2019), value-added Intellectual capital (VAIC) is calculated as:

$$VAIC=SCE+CEE+HCE \longrightarrow \quad (1)$$

Where SCE is structural-capital-efficiency, CEE is capital-employed-efficiency, and HCE is human-capital-efficiency.

According to the various studies i.e., (Bontis & Fitz-enz, 2002; Pulic, 2004; Maji & Goswami, 2016; Haris et al., 2018; Weqar & Haque, 2022); value added is calculated by:

$$\text{Value added (VA)}=EBIT+PC+D+A \longrightarrow \quad (2)$$

where EBIT is earnings before interest and tax, PC is personal cost like wages, salaries and other expense, A is amortization and D is depreciation.

$$CEE = \frac{VA}{CE} \longrightarrow \quad (3)$$

where CE is capital employed:
CE= total assets – total liabilities ⟶ (4)

$$HCE = \frac{VA}{HC} \quad (5)$$

where HC is the personal cost.

$$SCE = \frac{SC}{VA} \quad (6)$$

where SC is a capital structure:
SC = VA-HC ⟶ (7)

3.3 Construction of Portfolios

Portfolios have been constructed based on single sorting and double sorting. In single sorting, the sorting criteria is Intellectual Capital (IC). The value of IC and market value was taken at time ‘t-1’ while excess returns were taken at time ‘t’. After calculations, decile portfolios were formed both equally-weighted and value-weighted.

In double sorting, keeping the size factor fixed at the end of June of year *t*, stocks are assigned to one of the three IC portfolios. The intersections of these independent double-sorts result in size and IC portfolios. After the portfolio construction, the annualized returns for these portfolios are calculated.

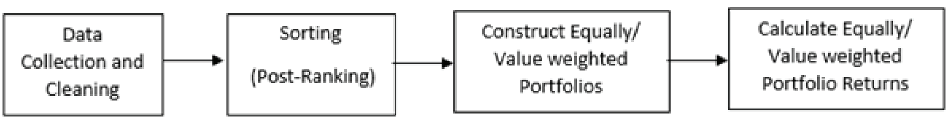

Figure 1: Flowchart for construction of portfolios

3.4 Construction of Factors

To test the Fama-French three and five model, their respective factors are constructed; namely size (SMB), value (HML), investment (CMA) and profitability (RMW) using the method given by Fama and French (1993) and Fama and French (2015) for the three-factor and five-factor model respectively. For size-factor, two groups were formed by dividing the data in halves based on small and big market cap. For the value-factor, data of book-to-market was divided in three groups (low, neutral, high) using median break-up point thirtieth and seventieth percentiles. For profitability-factor, data on operating-profit was divided into three groups (weak, neutral, robust) using median with break-up point of thirtieth and seventieth percentiles. For investment-factor, data on investment was divided in three groups (aggressive, neutral, conservative) using a median with break-up points of thirtieth and seventieth percentiles.

4. Empirical Analysis

4.1 Preliminary Findings

Table 1 shows descriptive statistics for each intellectual capital portfolio for the full sample (July 2000-June 2021) on Shanghai Stock Exchange. The portfolios are sorted on basis of intellectual capital. P1 is the portfolio of firms with the lowest intellectual capital and P10 is the portfolio of firms with the highest intellectual capital. In the equally-weighted portfolios, P9 and P10 have more returns as compared to P1 and P2; showing that the returns are increasing from P1 to P10. Similar pattern is observed in value-weighted portfolios as well. The table also shows the average market value in million yuan of shares for P1 to P10. P1 has lowest average market value and P10 has higher average market value compared to other portfolios. We can notice, that here low market value companies have fewer returns and high market value companies have high return showing no size effect.

We observe that the firms with low IC have lower returns and firms with high IC have higher returns. An investor can accept a low premium for holding shares of low IC firms (P1) while it would pay a higher premium for holding higher IC firm (P10) shares. the literature indicates that higher levels of intellectual capital (IC) are associated with greater returns (Bayraktaroglu et al., 2019; Saeed et al., 2016) As a result, our investment strategy is set to be P10-P1. The spread of P10-P1 is positive and significant in both equal-weighted and value-weighted portfolios; hence fulfilling our investment strategy.

Table 1
Intellectual capital portfolios: Characteristics and performance

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1	t-stat
EW Return (%)	0.96	5.53	9.24	8.15	8.32	10.06	10.85	12.74	13.34	14.13	13.17	3.52
VW Return (%)	-3.73	-0.66	2.68	2.07	1.56	2.58	3.53	5.15	8.84	6.47	10.20	2.11
Avg. MV (CNY m)	0.56	0.73	0.92	1.03	0.97	0.95	1.07	1.29	1.53	2.83	2.27	17.64
CAPM Beta	0.99	1.01	1.05	1.01	1.02	1.00	0.98	1.01	1.00	1.04	0.05	1.27

The table shows descriptive statistics of decile portfolios sorted on IC of the firms listed on Shanghai Stock Exchange from July 2000 to June 2021. EW and VW returns are per annum. ***, **, * is significance-level at 1%, 5%, 10% respectively.

4.2 Risk-adjusted Asset Pricing

Here, the performance of time-series is estimated for ten portfolios sorted on intellectual capital; using CAPM, FF3F and FF5F asset-pricing models.

First, Jensen-alpha is calculated for CAPM; followed by alphas of FF three and five factor models:

$$R_{it} - R_t^f = \alpha_{capm} + \beta_{\mathrm{Mi}}(R_{\mathrm{Mt}} - R_t^f) + \epsilon_{it} \longrightarrow \quad (8)$$

$$R_{it} - R_t^f = \alpha_{ff3} + \beta_{\mathrm{Mi}}(R_{\mathrm{Mt}} - R_t^f) + \beta_{\mathrm{i,SMB}}(SMB_{\mathrm{t}}) + \beta_{\mathrm{i,HML}}(HML_{\mathrm{t}}) + \epsilon_{it} \longrightarrow \quad (9)$$

$$R_{it} - R_t^f = \alpha_{ff5} + \beta_{\mathrm{Mi}}(R_{\mathrm{Mt}} - R_t^f) + \beta_{\mathrm{i,SMB}}(SMB_{\mathrm{t}}) + \beta_{\mathrm{i,HML}}(HML_{\mathrm{t}}) + \beta_{\mathrm{i,RMW}}(RMW_{\mathrm{t}}) + \beta_{\mathrm{i,CMA}}(CMA_{\mathrm{t}}) + \epsilon_{it} \longrightarrow \quad (10)$$

Where α_{capm} is the Jensen alpha for CAPM; α_{ff3} and α_{ff5}, are alphas for FF3F and FF5F models respectively; R_{it} is return of portfolio 'i' in month 't', R_{Mt} is the return of market portfolio in month 't' and R^t_f is risk-free return for month 't'. SMB, HML, RMW and CMA are the size, value, profitability and investment factors respectively. The above models are estimated using Generalized Method of Moments with Newly-Wested approach of heteroscedastcity and serial-correlation standard errors.

Panel A of Table 2 presents alphas of the ten equal-weighted portfolios sorted on intellectual capital. P1 represents the equal weighted portfolios with lowest IC and P10 represents EW portfolios with highest IC. Furthermore, the table shows if the behavior of P1 and P10 is different or not. In all the models (CAPM, FF3F and FF5F), alpha values show an increasing trend from P1 to P10. P10 which contains shares of high IC firms has annualized Jensen alpha of 14.20% pa (t=2.17), Fama French three factor alpha of 20.36% pa. (t=2.78) and Fama French five factor alpha of 16.31% pa. (t=2.17).

The spread of P10 - P1 is positive and significant yielding abnormal performance for all the models: for CAPM it is 13.16% pa. (t= 3.53), for FF3F is 14.50% pa. (t=3.69) and for FF5F is 14.10% pa. (t=3.57). These findings prove that IC is significantly priced at the Shanghai Stock Exchange over-and-above market, value, size, investment and profitability.

Wald test has been used to evaluate the significance of pricing errors of the models and examine the joint significance of all the portfolios' alpha. Wald test rejects null hypothesis of zero jointly alphas estimates; CAPM (p=0.004), FF3F (p=0.0009) and FF5F (p=0.0016); indicating that all portfolios are different from each other. They are different assets. The partial difference between P10 and P1 is positive and significant in CAPM, FF-3F and FF-5F; thus all models fail to explain; showing existence of partial investment strategy. People can take long position in P10 and short positon in P1.

Panel B shows alphas of the ten value-weighted portfolios sorted on intellectual capital. The spread strategy of P10 - P1 has abnormal performance for all the models. These support that intellectual capital is significantly priced on Shanghai Stock Exchange. This suggests that intellectual capital can be considered as risk-factor and priced significantly on Shanghai Stock Exchange.

The above results suggest that intellectual capital can be considered as risk-factor and be priced significantly on Shanghai Stock Exchange.

Table 2

Intellectual capital portfolios: Alphas

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1	Chi-sq.
					Panel A: Equal weighted portfolios sorted on intellectual capital							
CAPM	1.03	5.59	9.29	8.19	8.37	10.11	10.90	12.78	13.40	14.20	13.16	25.80
Alpha	(0.14)	(0.79)	(1.30)	(1.20)	(1.22)	(1.52)	(1.70)*	(2.01)**	(2.12)**	(2.17)**	(3.53)***	[0.00]***
FF3F-	5.86	9.91	13.17	12.48	12.42	14.48	15.73	17.75	18.43	20.36	14.50	29.93
Alpha	(0.75)	(1.28)	(1.71)*	(1.69)*	(1.66)*	(2.00)**	(2.23)**	(2.53)**	(2.67)***	(2.78)***	(3.69)***	[0.00]***
FF5F-	2.21	4.72	7.70	7.85	7.82	9.85	12.07	14.01	15.03	16.31	14.10	28.35
Alpha	(0.27)	(0.58)	(0.94)	(1.02)	0.99	(1.31)	(1.66)*	(1.91)**	(2.12)**	(2.17)**	(3.57)***	[0.00]***
					Panel B: Value weighted portfolios sorted on intellectual capital							
CAPM	-3.67	-0.61	2.72	2.11	1.59	2.61	3.58	5.19	8.88	6.51	10.18	13.02
Alpha	(-0.52)	(-0.09)	(0.39)	(0.33)	(0.24)	(0.41)	(0.61)	(0.88)	(1.53)	(1.12)	(2.12)**	[0.22]
FF3F-	-0.64	1.90	5.83	6.46	5.80	6.59	7.35	8.43	12.36	8.93	9.57	17.21
Alpha	(-0.09)	(0.26)	(0.79)	(0.96)	(0.82)	(0.99)	(1.19)	(1.33)	(1.99)**	(1.48)	(1.95)*	[0.07]***
FF5F-	-4.17	-1.82	1.78	2.91	2.65	2.55	4.14	5.46	9.81	5.92	10.09	16.62
Alpha	(-0.52)	(-0.23)	(0.22)	(0.41)	(0.35)	(0.37)	(0.62)	(0.80)	(1.51)	(0.96)	(2.00)**	[0.08]***

This table shows annualized alphas of the decile portfolios sorted on intellectual capital. The t-stats is in parenthesis and p-value is in brackets. ***, ** and * is significance-level at 1%, 5% and 10% respectively

4.3 Cross-Sectional Analysis

To check whether the risk factors are able to describe the variation in cross-sectional returns of portfolios; two-stage Fama-Macbeth (1973) regression is performed using decile portfolios sorted on intellectual capital. In stage one, time-series regression is done and beta coefficients are estimated for each decile portfolio as given in equations 8,9 and 10. In the stage two, cross sectional regression is done between excess return and beta (from stage one). Cross-sectional analysis is done on CAPM, FF3F and FF5F models using following equations.

$$R_{it} - R_t^f = \lambda_0 + \lambda_{\mathrm{Mt}} \hat{\beta}_{\mathrm{i,M}} + \forall_{it} \longrightarrow \quad (11)$$

$$R_{it} - R_t^f = \lambda_0 + \lambda_{\mathrm{Mt}} \hat{\beta}_{\mathrm{i,M}} + \lambda_{\mathrm{SMBt}} \hat{\beta}_{\mathrm{i,SMB}} + \lambda_{\mathrm{HMLt}} \hat{\beta}_{\mathrm{i,HML}} + \forall_{it} \longrightarrow \quad (12)$$

$$R_{it} - R_t^f = \lambda_0 + \lambda_{\mathrm{Mt}} \hat{\beta}_{\mathrm{i,M}} + \lambda_{\mathrm{SMBt}} \hat{\beta}_{\mathrm{i,SMB}} + \lambda_{\mathrm{HMLt}} \hat{\beta}_{\mathrm{i,HML}} + \lambda_{\mathrm{RMWt}} \hat{\beta}_{\mathrm{i,RMW}} + \lambda_{\mathrm{CMAt}} \hat{\beta}_{\mathrm{i,CMA}} + \forall_{it} \longrightarrow \quad (13)$$

Cross-sectional test was done on the decile portfolios constructed on the basis of intellectual capital. Table 3 shows the estimated risk-premium coefficients of the IC sorted portfolios for CAPM, FF3F and FF5F. From Panel A (equal weighted portfolios), we can see that for all models i.e. CAPM, FF-3F and FF-5F, cross-sectional relation between market beta and portfolio returns is negative and significant which is contradictory to the theory of CAPM similar to studies by (Florackis et al., 2011; & Kostakis et al., 2012). The same result occurs when size, value, investment and profitability factors are introduced. The size factor is positive and significant in both FF-3F and FF-5F. The value factor is negative and significant in FF3F. However, the value, profitability and investment factors in FF-5F have no significance over cross-sectional portfolio returns. Further, it can be seen that the R-square is increased when more risk factors are included in the models while adjusted R-square is very low for all models. The intercept is positive and significant for CAPM and insignificant for F-3F and FF-5F. These findings indicate that these asset-pricing models do not explain variation in cross-sectional returns of portfolios sorted on intellectual; capital; which gives us an indication to add more factor(s) i.e. leading to constructing intellectual capital factor.

Panel B (value weighted portfolios) in table 3, for all models, cross-sectional relation between market beta and portfolio returns is negative and significant which is contradictory to theory of CAPM. The size, value and profitability factors in FF-3F and FF-5F are negative and have no significance on cross-sectional portfolio returns. Further, it can be seen that the R-square is increased when more risk factors are included in the models while the adjusted R-square is very low for all models. The coefficient of the intercept is positive and insignificant for CAPM; while the intercept is positive and significant for FF-3F and FF-5F; this is known as model misspecification. These findings indicate that these asset-pricing models do not explain the variation in cross sectional portfolio returns; which gives us an indication to add more factor(s) i.e. leading to constructing intellectual capital factor.

Table 3

Intellectual capital portfolios: Cross-sectional asset-pricing tests

	λ_0	λ_M	λ_{SMB}	λ_{HML}	λ_{RMW}	λ_{CMA}	R^2	Adj. R^2
	Panel A: Equal weighted portfolios sorted on intellectual capital							
CAPM	0.0147	-0.0543					0.19	0.09
	(2.19)**	(-2.40)**						
FF3F	0.0004	-0.1267	0.0633	-0.0322			0.54	0.31
	(0.05)	(-3.70)***	(2.99)**	(-2.31)**				
FF5F	0.0072	-0.1856	0.1193	-0.0138	0.0012	0.0253	0.71	0.35
	(0.67)	(-3.66)***	(3.38)**	(-0.83)	(0.07)	(2.07)**		
	Panel B: Value weighted portfolios sorted on intellectual capital							
CAPM	0.0078	-0.0591					0.14	0.04
	(1.44)	(-2.52)**						
FF3F	0.0126	-0.0691	-0.0210	-0.0067			0.41	0.12
	(1.71)*	(-2.56)**	(-1.42)	(-0.41)				
FF5F	0.0202	-0.0601	-0.0162	-0.0015	-0.0072	0.0214	0.65	0.23
	(2.20)**	(-2.45) **	(-1.24)	(-0.09)	(-0.36)	(1.24)		

This table shows risk-premium coefficient (λ). t-stats are in parenthesis. The last columns show R2 *and adj. R2 are from the second-stage FMB regression. ***, **, * is significance-level at 1%, 5%, 10% respectively.

4.4 Double sorted Portfolios

Table 4 shows the average annualized returns of the ten portfolios sorted on size and intellectual capital of China from July 2000 to June 2021. Across each IC group (low, medium and high), average return increases as the size increases; indicating the presence of a size effect in the Shanghai stock exchange. In every size group, the high IC portfolio outperforms the low IC portfolios. This shows the presence of IC effect in the market.

Table 4
Size and Intellectual capital portfolios: Characteristics and performance

	Low	Medium	High	High-Low
Small	-7.26	-1.18	3.33	10.59
	(-0.88)	(-0.15)	(0.44)	(4.22)***
Big	-1.15	1.00	5.10	6.25
	(-0.14)	(0.13)	(0.75)	(2.29)**

The table shows average annualized returns of the size and IC sorted portfolios of firms listed on Shanghai Stock Exchange. The t-stats is reported in parenthesis ***, **, * is significance-level at 1%, 5%, 10% respectively.

Table 5 shows the intercepts (alphas) of CAPM, FF3F and FF5F and their t-stats of the full sample time-series regression applied on the portfolios double-sorted on size and IC. When double sorting was done on size and IC with size kept constant; we see from table 5 that P10-P1, is significant and positive for CAPM and FF3F for both small and big size firms while in the case of FF5F, results for small size firms are significant and positive. These results show that IC can be added to the models as an additional risk factor.

Table 5
Alphas of size-IC portfolios

	Low	Medium	High	High-Low
		CAPM (%p.a.)		
Small	-6.60	-0.55	3.95	10.56
	(-1.33)	(-0.13)	(1.00)	(4.24)***
Big	-0.47	1.64	5.73	6.21
	(-0.11)	(0.48)	(2.28)**	(2.31)**
		FF3F (%p.a.)		
Small	0.55	4.03	12.50	11.95
	(0.18)	(1.39)	(4.43)***	(4.61)***
Big	-1.83	-0.26	4.41	6.24
	(-0.53)	(-0.08)	(1.83)*	(2.69)**
		FF5F (%p.a.)		
Small	7.33	7.36	13.05	5.71
	(2.70)**	(2.38)**	(4.33)***	(2.77)**
Big	5.23	2.64	5.68	0.45
	(1.58)	(0.81)	(2.22)**	(0.22)

This table shows annualized alphas of size-IC sorted portfolios. The t-stats is in parenthesis. ***, **, * is significance-level at 1%, 5%, 10% respectively.

4.5 IC Augmented Model

From the cross-section and double sorting results we see that there is a need to add a factor to the model. Therefore, the factor of Intellectual Capital has been constructed using the approach by Moreno and Rodriguez (2009), Harvey and Siddique (2000), and Kostakis et al. (2012). First, we sort the shares every month in accordance to their IC values. Then, we allot the 15% (in terms of market-value) of the shares with the highest IC estimated values to portfolio IC+ and the 15% of the shares with the lowest IC estimated values to portfolio IC- and compute their equally-weighted returns. IC factor has been defined as spread return (IC+ - IC-). This factor is then augmented in CAPM, FF3F and FF5F models; and FMB regression is performed again. In stage one, time-series regression is done and beta coefficients are estimated for each decile portfolio as given in equations 14, 15 and 16.

$$R_{it} - R_t^f = \alpha_{capm} + \beta_{\mathrm{Mi}}\,(R_{\mathrm{Mt}} - R_t^f) + \beta_{\mathrm{i,IC}}\,(IC_{\mathrm{t}}) + \in_{it} \longrightarrow \quad (14)$$

$$R_{it} - R_t^f = \alpha_{ff3} + \beta_{\mathrm{Mi}}\,(R_{\mathrm{Mt}} - R_t^f) + \beta_{\mathrm{i,SMB}}\,(SMB_{\mathrm{t}}) + \beta_{\mathrm{i,HML}}\,(HML_{\mathrm{t}}) + \beta_{\mathrm{i,IC}}\,(IC_{\mathrm{t}}) \;\; \in_{it} \quad (15)$$

$$R_{it} - R_t^f = \alpha_{ff5} + \beta_{\mathrm{Mi}}\,(R_{\mathrm{Mt}} - R_t^f) + \beta_{\mathrm{i,SMB}}\,(SMB_{\mathrm{t}}) + \beta_{\mathrm{i,HML}}\,(HML_{\mathrm{t}}) + +\beta_{\mathrm{i,RMW}}(RMW_{\mathrm{t}}) + \beta_{\mathrm{i,CMA}}\,(CMA_{\mathrm{t}}) + \beta_{\mathrm{i,IC}}\,(IC_{\mathrm{t}}) + \in_{it} \longrightarrow \quad (16)$$

In stage two, cross-sectional regression is done between excess return and beta (from stage one). Cross-sectional analysis is done on augmented CAPM, FF3F and FF5F models using the following equations.

$$R_{it} - R_t^f = \lambda_0 + \lambda_{\mathrm{Mt}}\hat{\beta}_{\mathrm{i,M}} + \lambda_{\mathrm{ICt}}\hat{\beta}_{\mathrm{i,IC}} + \forall_{it} \longrightarrow \quad (17)$$

$$R_{it} - R_t^f = \lambda_0 + \lambda_{\mathrm{Mt}}\hat{\beta}_{\mathrm{i,M}} + \lambda_{\mathrm{SMBt}}\hat{\beta}_{\mathrm{i,SMB}} + \lambda_{\mathrm{HMLt}}\hat{\beta}_{\mathrm{i,HML}} + \lambda_{\mathrm{ICt}}\hat{\beta}_{\mathrm{i,IC}} + \forall_{it} \longrightarrow \quad (18)$$

$$R_{it} - R_t^f = \lambda_0 + \lambda_{\mathrm{Mt}}\hat{\beta}_{\mathrm{i,M}} + \lambda_{\mathrm{SMBt}}\hat{\beta}_{\mathrm{i,SMB}} + \lambda_{\mathrm{HMLt}}\hat{\beta}_{\mathrm{i,HML}} + \lambda_{\mathrm{RMWt}}\hat{\beta}_{\mathrm{i,RMW}} + \lambda_{\mathrm{CMAt}}\hat{\beta}_{\mathrm{i,CMA}} + \lambda_{\mathrm{ICt}}\hat{\beta}_{\mathrm{i,IC}} + \forall_{it} \longrightarrow \quad (19)$$

Table 6 presents the estimated coefficients of the ten IC - sorted portfolios from the second-stage regression. Table 7 presents the estimated risk-premium coefficients using a restricted version of the models, where the intercept λ0 equals to zero which is its correct value theoretically. It is confirmed from the results that the IC factors have significant explanatory power over the cross-section of IC portfolio returns. From CAPM we can say, a single factor-loading of IC risk significantly generates a 1.02% monthly premium across equal weighted IC portfolios in equal and a 0.78% monthly premium across value weighted IC portfolios. Adjusted R-square of the model is as maximum as 44% in every case which is more than those obtained from CAPM, FF3F and FF5F models.

Table 6

Unrestricted Cross-sectional Analysis of IC augmented models

	λ 0	λ M	λ SMB	λ HML	λ RMW	λ CMA	λ IC	R^2	Adj. R^2
	Panel A: Equal weighted portfolios sorted on intellectual capital								
CAPM-IC	0.0138	-0.0259					0.0102	0.49	0.35
	(2.03)**	(-1.10)					(3.60)***		
FF3F-IC	0.0171	-0.007	0.0047	0.0282			0.0104	0.64	0.36
	(1.57)	(-0.22)	(0.2)	(1.86)*			(3.65)***		
FF5F-IC	0.0155	-0.013	0.0113	0.0262	0.0021	0.001	0.0103	0.81	0.44
	(1.44)	(-0.40)	(0.45)	(1.70)*	(0.13)	(0.1)	(3.61)***		
	Panel B: Value weighted portfolios sorted on intellectual capital								
CAPM-IC	0.0039	-0.0183					0.0078	0.41	0.24
	(0.67)	(-0.86)					(2.01)**		
FF3F-IC	0.0031	-0.0086	0.0086	0.0104			0.0079	0.57	0.23
	(0.4)	(-0.34)	(0.93)	(0.7)			(1.94)**		
FF5F-IC	0.0095	-0.0212	0.0027	0.0101	-0.0053	0.0119	0.0059	0.77	0.3
	(1.10)	(-0.80)	(0.27)	(0.67)	(-0.28)	(0.84)	(1.43)		

This table shows risk-premium coefficient (λ). t-stats is reported in parenthesis. Last columns show R2 *and adj. R2 are from second-stage FMB regression. ***, **, * is significance-level at 1%, 5%, 10% respectively.

Table 7

Restricted Cross-sectional Analysis of IC augmented models

	λ 0	λ M	λ SMB	λ HML	λ RMW	λ CMA	λ IC	R^2	Adj. R^2
	Panel A: Equal weighted portfolios sorted on intellectual capital								
CAPM-IC	-	-0.0246					0.0102	0.49	0.35
		(-1.04)					(3.61)***		
FF3F-IC	-	0.0067	-0.0076	0.0256			0.0104	0.64	0.36
		(0.22)	(-0.28)	(2.22)**			(3.66)***		
FF5F-IC	-	0.0065	-0.0074	0.0255	0.0083	-0.0065	0.0104	0.81	0.44
		(0.20)	(-0.24)	(1.91)**	(0.45)	(-0.43)	(3.70)***		
	Panel B: Value weighted portfolios sorted on intellectual capital								
CAPM-IC	-	-0.0173					0.0079	0.41	0.24
		(-0.81)					(2.02)**		
FF3F-IC	-	-0.0174	0.0021	0.0134			0.0074	0.57	0.23
		(-0.69)	(0.20)	(0.94)			(1.84)*		
FF5F-IC	-	-0.0230	0.0020	0.0138	0.0047	0.0018	0.0066	0.75	0.26
		(-0.86)	(0.19)	(0.96)	(0.23)	(0.10)	(1.56)		

This table shows risk-premium coefficient (λ). t-stats is in parenthesis. Last columns show R2 *and adj. R2 are from second-stage FMB regression. ***, **, * is significance-level at 1%, 5%, 10% respectively.

5. Conclusion

The primary objective of the study was to empirically evaluate how well traditional asset pricing models, such as CAPM, FF3F, and FF5F, explain the variations in returns of intellectual capital portfolios of the Shanghai Stock Exchange. The second objective of this study was to extend traditional asset pricing models by incorporating a factor derived from intellectual capital to assess risk in the context of intellectual capital.

Initially, the CAPM, FF3F and FF5F were tested with portfolios constructed based on IC; the results of descriptive statistics align with the literature suggesting higher IC is associated with higher returns (Saeed et al., 2016; Bayraktaroglu et al., 2019). The time-series and cross-sectional results showed that the traditional asset-pricing models do not fully explain the variation in returns based on IC. This indicated a need for an additional factor, such as IC, to better explain portfolio returns. Hence, after adding the IC factor in all the models, the results supported the robustness of IC as a priced risk factor in the Shanghai Stock Exchange. This is consistent with the findings of the study conducted by Maharani and Narsa (2023) on the Indonesian stock market.

This study contributes to the existing literature by underlining the significance of intellectual capital and its role in estimating cross-sectional returns. The study concludes that intellectual capital is a significant factor in asset pricing. Traditional models like CAPM, FF3F, and FF5F fail to capture the full impact of IC on returns. Incorporating IC into asset pricing models improves their explanatory power, suggesting that IC should be considered a key risk factor in financial markets.

The empirical findings of the study underscore the importance of intellectual capital, suggesting that investors should consider this factor when deciding on investments. The results can help financial advisors in assessing market risk and developing investment strategies.

The current study focuses on the stock market of China and can be expanded to other emerging markets, including India, Pakistan, and others. This study could also be applied to developed markets such as the USA, Japan, and beyond. Moreover, the data definitions could be broadened by using alternative proxies for the variables.

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APPENDIX A

Definitions of Variables

Variable Name	Mnenomic Code	Definition
Price	P	The most recent price from the relevant market in the primary currency units.
Common Equity	WC03501	The investment made by common shareholders in a firm.
Depreciation	WC01148	Process of distributing the cost of a depreciable asset over the accounting periods within its anticipated useful life.
Earnings before Interest & Taxes	WC18191	Firm's earnings before interest expense and income taxes
Income Taxes	WC01451	All income taxes imposed on a firm's earnings
Number of Share-in-Issue	NOSH	The total number of ordinary shares that constitute the firm's capital.
Total Assets	WC02999	Sum of total current assets, net property, plant and equipment, investment in unconsolidated subsidiaries, long term receivables, other investments, and other assets.
Total Liabilities	WC03351	All short-term and long-term obligations that the firm is expected to fulfill..
Salaries & Benefits Expense	WC01084	Wages paid to the firm's employees.

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