

IS HUMAN CAPITAL THE SIXTH FACTOR? EVIDENCE FROM US DATA

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Abstract

Problem/Relevance: *Measuring the risk of an asset and the economic forces driving the price of the risk is a challenging task that preoccupied the asset pricing literature for decades. However, there exists no consensus on the integrated asset pricing framework among the financial economists in the contemporaneous asset pricing literature. Thus, we consider and study this research problem that has greater relevance in pricing the risks of an asset. In this backdrop, we develop an integrated equilibrium asset pricing model in an intertemporal (ICAPM) framework.*

Research Objective/Questions: *Broadly we have two research objectives. First, we examine the joint dynamics of the human capital component and common factors in approximating the variation in asset return predictability. Second, we test whether the human capital component is the unaccounted and the sixth pricing factor of FF five-factor asset pricing model. Additionally, we assess the economic and statistical significance of the equilibrium six-factor asset pricing model.*

Methodology: *The human capital component, market portfolio, size, value, profitability, and investment are the pricing factors of the equilibrium six-factor asset pricing model. We use Fama-French (FF) portfolios of 2×3 , 5×5 , 10×10 sorts, $2 \times 4 \times 4$ sorts, and the Industry portfolios to examine the equilibrium six-factor asset pricing model. The Generalized method of moments (GMM) estimation is used to estimate the parameters of variant asset pricing models and Gibbons-Ross-Shanken test is employed to evaluate the performance of the variant asset pricing frameworks.*

Major Findings: *Our approaches led to three conclusions. First, the GMM estimation result infers that the human capital component of the six-factor asset pricing model significantly priced the variation in excess return on FF portfolios of variant sorts and the Industry portfolios. Further, the sensitivity to human capital component priced separately in the presence of the market portfolios and the common factors. Second, the six-factor asset pricing model outperforms the CAPM, FF three-factor model, and FF five-factor model, which indicates that the human capital component is a significant pricing factor in asset return predictability. Third, we argue that the human capital component is the unaccounted asset pricing factor and equally the sixth-factor of the FF five-factor asset pricing model.*

The additional robustness test result confirms that the parameter estimation of the six-factor asset pricing model is robust to the alternative definitions of the human capital component.

Implications: *The empirical results and findings equally pose the more significant effects for the decision-making process of the rational investor, institutional managers, portfolio managers, and fund managers in formulating the better investment strategies, which can help in diversifying the aggregate risks.*

Keywords: *Asset pricing; FF five-factor model; human capital; return predictability; six-factor asset pricing model; sixth factor.*

JEL classification: *E24; G11; G12*

Introduction

Pricing the risk of an asset and the economic forces governing the price of the risks are the challenging issues that preoccupied the asset pricing literature for decades. In this succession Lintner (1965), Mossin (1966) and Sharpe (1964) developed the capital asset pricing model (CAPM), which measures the risks of an asset by the covariance of asset's return with the return on all invested wealth of an economy, also known as the 'market portfolio'. The market portfolio in empirical research is usually proxied by the yield on the value-weighted stock market index. Blume & Friend (1973) estimated an equilibrium model and suggested that the price of the market portfolio is the relative risk aversion of the representative agent.

Even though the practitioners primarily use the CAPM because of its practical implications, it faced several criticisms from various directions. Merton (1973) criticized the assumptions drawn to derive the model whereas a group of researchers emphasized that the risk of an asset is measured by its covariance with the marginal utility of the representative agents. In the intertemporal framework, the innovations in marginal utility can be determined through changing expectations of future returns, which not only drive the marginal productivity of wealth but the increment to wealth itself.

The most critical assumption considered to test the CAPM is that the aggregate stock market index can adequately proxy the market portfolio as opposed by Roll (1977). Based on the argument that the return on the market portfolio cannot be measured accurately by the yield on the stock market index. In response to these criticisms, a handful of financial economists favored multi-factor models, in which the covariances measure the risk with the common factors. Following Chen et al. (1986) employ a multi-factor model to price the risk, consisting of innovations to essential macroeconomic variables witnessed a better empirical fit to the cross-sectional asset returns data. These sort of multi-factor models needs weak theoretical assumptions.

Consequently, Fama & French (1993) introduced a three-factor model consisting of size, book-to-market, and market portfolio as the asset pricing factors. The Fama-French (FF) three-factor model fits the cross-sectional returns data remarkably well. In the spirit of the factor-based model, Carhart (1997) accommodated momentum as a pricing factor to the FF three-factor model and proposed a four-factor framework. Further, the empirical results suggest that the sensitivity to momentum strategy priced separately in the presence of FF pricing factors. The greater empirical

success of the factor-based asset pricing models has been witnessed in the asset pricing literature but fails to provide the economic justification. Concurrently, Fama & French (2015) proposed a five-factor model by adding profitability and investment factors to the FF three-factor model, which performs poorly because of its inability to capture the low average returns on small stocks. In addition, Fama & French (2017); Gregoriou, Racicot, & Théoret (2016); and Racicot & Rentz (2016) confirms the failure of the FF five-factor asset pricing model in asset return predictability.

Moreover, the sizeable empirical evidence favoring the factor-based models in the asset pricing literature fail to resolve the two critical issues. First, how the risk of an asset be measured? Second, what dynamic economic forces drive the price of the risk?

Campbell (1996) employ a multi-factor model in an intertemporal framework, which consists of innovations in return on market portfolio and human capital¹ component as the pricing factors. He concluded that the coefficient of relative risk aversion is relatively higher than the price of the risk attached to the market portfolio. Lustig & Van Nieuwerburgh (2008) opines that the human capital and financial wealth² equally play an important role in pricing the risk of an asset, and the joint dynamics of both the components possess more significant implications for aggregate wealth³ dynamics. Campbell (2000) estimated labor income is two-thirds of United States (US) GDP (Gross domestic product) whereas the capital income is mere one-third of GDP. Lustig et al. (2013) argue that the financial (stock market) wealth is mere 1% and all non-human wealth is only 8%, whereas 92% is human wealth among the aggregate household wealth of US. Following, Palacios (2015) suggest that the share of human capital in the total wealth is approximately 93%.

Berk & Walden (2013); Betermier, Jansson, Parlour, & Walden (2012); Lustig & Van Nieuwerburgh (2008); and Santos & Veronesi (2006) provide the empirical evidence that human capital component is highly correlated with the expected stock returns. Similarly, Campbell (1996) suggest that introducing FF pricing factors to their intertemporal capital asset pricing (ICAPM) framework that consists of the human capital component along with macroeconomic variables may yield better results, which further deepen our understanding of dynamics governing the risk and return relationship. Subsequently, Roy & Shijin (2018) developed an equilibrium multifactor asset pricing model consisting of the market portfolio, human capital, bond market factors, and FF factors alongside the momentum factor. They test the equilibrium model in both ICAPM and consumption-based CAPM (CCAPM) frameworks across the economies. Further, they conclude that the market portfolio and human capital component are the only significant priced factors in return predictability across the marketplaces, and FF factors, bond market factors, and momentum factor becomes redundant. These findings along with the human capital backed asset pricing literature indicating the importance of the human capital component in asset return predictability.

The joint dynamics of the financial and human wealth components shares and drives the dynamics in aggregate wealth of an economy is well documented in the asset pricing literature. Simultaneously, there exists evidence in the asset pricing literature that the sensitivity of the human capital beta is over and above the sensitivity of market returns beta in the asset return predictability. However, there exist the greater indifference of consensus between the proponents supporting factor-based asset pricing framework and the proponents favoring the human capital adjusted asset

¹ Human capital as defined in macroeconomics, is the sum of the discounted value of current and future labor income (Fama & Schwert, 1977; Lettau & Ludvigson, 2001; Mayers, 1972; Ren, Yuan, & Zhang, 2014; Sousa, 2012a, 2012b).

² Financial wealth is the tradable financial assets, which proxied by aggregate stock index (Campbell, 2015).

³ Aggregate wealth is the sum of human capital and asset holdings (Jagannathan & Wang, 1996).

pricing framework. The lack of agreement between these proponents and similarly the unavailability of an integrated asset pricing framework motivates us to study these issues thoroughly and provide the cohesive explanation, which can develop the consensus between both the approaches. Hence, we undertake this complex issue persisting in the asset pricing literature, which has a greater emphasis for the rational investors, fund managers, institutional investment managers, and relative key stakeholders concerning their investment strategies formulation and decision-making process.

We follow the suggestion made by Campbell (1996) and model the human capital component along with the FF asset pricing factors (common factors) in an ICAPM framework to price the risk associated with an asset. Hence, by doing so, we tend to draw an intertemporal structure that satisfies the conditions of both the proponents where human capital component and common factors jointly assess the risks of an asset. Further, the inclusion of human capital component with the FF five-factor model consisting of the market portfolio, size, value, investment, and profitability as the pricing factors would suffice the issue of an integrated equilibrium asset pricing model. Further, the ICAPM framework would also uncover the puzzle, whether the human capital component is the sixth factor. Briefly, we study the objectives of this paper into two phases. First, we test the joint dynamics of the human capital component and common factors in asset return predictability. Second, we check whether the human capital component is the sixth factor. Further, we also examine the economic and statistical significance of our equilibrium six-factor asset pricing model.

To achieve the objectivity of the study, we use the generalized method of moments (GMM) to uncover the joint dynamics of the human capital component and common factors in asset return predictability. Similarly, we use the GRS (Gibbons-Ross-Shanken) test statistics of Gibbons et al. (1989) to evaluate the economic and statistical performance of the variant asset pricing models. We employ FF 2×3 , 5×5 , and 10×10 sorts of Size-B/M, Size-OP, Size-Investment portfolios, $2 \times 4 \times 4$ sorts of Size-B/M-OP, Size-B/M-Investment, Size-OP-Investment portfolios, and the sets of 5, 10, 12, 17, 30, 48, and 49 Industry portfolios, to test the significance of the models used in the study. We revisit the CAPM, FF three-factor model, and FF five-factor models to check and evaluate the statistical and economic viability of the proposed six-factor asset pricing model.

Our approaches led to three conclusions. First, the GMM estimation results show that the human capital component of the six-factor asset pricing framework significantly priced the variation in excess return on the FF portfolios of 2×3 , 5×5 , 10×10 , $2 \times 4 \times 4$ sorts and the Industry portfolios. Moreover, the empirical results further reveal that the sensitivity of the human capital component priced separately in the presence of the market portfolio and the common factors. Second, GRS test rejects the CAPM, FF three-factor model, and FF five-factor model whereas the six-factor asset pricing model convincingly passes the GRS test across the FF portfolios of variant sorts and the FF Industry portfolios. These results indicate that human capital is indeed a significant component of aggregate wealth and equally a key asset pricing factor in asset return predictability. Third, the GMM estimation and GRS test results infer that our proposed integrated equilibrium six-factor asset pricing model is statistically and economically capable of assessing the variation in excess returns across the FF variant portfolios. Conclusively, we argue that the human capital component is an unaccounted pricing factor and undoubtedly the sixth-factor of the FF five-factor asset pricing model.

The paper is organized as follows. The second section presents the data and variable definitions. The third section shows the mathematical notations of the variant asset pricing models.

The fourth section reports the summary statistics of the explanatory variables. In the fifth section, we discuss the empirical results of the variant asset pricing frameworks. The sixth section discusses the results of additional tests for robustness. Following, we give the empirical interpretation and summary of the study in section seven. The last section presents the concluding remarks.

Data and variable definitions

We develop an integrated equilibrium six-factor asset pricing framework consisting of the human capital component, market portfolio, and common factors as the underlying pricing factors. Specifically, the priced factors include labor income growth (LBR) and wealth-to-consumption ratio (WCR) measuring the return on human capital, value-weighted market index (RM-RF) measuring return on market portfolio, size (SMB), value (HML), profitability (RMW), investment (CMA), alongside momentum (WML). The brief description and definition of explanatory variables and the source of data collection are shown in Table 1. We use the FF portfolios of 2×3 , 5×5 , 10×10 sorts on size-B/M, size-OP, size-Investment, $2 \times 4 \times 4$ sorts on Size-B/M-OP, Size-B/M-Investment, Size-OP-Investment, and the Industry portfolios to assess the significance and performance of the variant asset pricing models along with the equilibrium six-factor asset pricing framework developed in the study. The data of FF test portfolio is retrieved from French - Data Library (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html). All the returns are expressed in US dollar (USD). The time-series dataset representing the variables are expressed in monthly frequency and the sample period ranges from January 1986 to December 2014. We discuss the econometric methodology in the following section.

Table 1 Variables definition and data specification

Variable code	Variable	Variable definition	Data source
RM-RF	Aggregate market	RM-RF is the excess return on the market, value-weight return on all the firms incorporated in the US and listed on the NYSE, AMEX, and NASDAQ minus the one month Treasury Bill rate	French (2019)
SMB	Small Minus Big	SMB is the difference between the average returns on the three small-stock portfolios (SL/BM, SM/BM, and SH/BM) and the average returns on the three big-stock portfolios (BL/BM, BM/BM, and BH/BM)	French (2019)
HML	High Minus Low	HML is the difference between the average returns on the two value portfolios (SH/BM and BH/BM) and the average returns on the two growth portfolios (SL/BM and BL/BM)	French (2019)
RMW	Robust Minus Weak	RMW is the difference between the average return on two robust operating profitability portfolios (S/HOP and B/HOP) and the average return on two weak operating profitability portfolios (S/LOP and B/LOP)	French (2019)
CMA	Conservative Minus Aggressive	CMA is the difference between the average return on two conservative investment portfolios (S/LoINV and B/LoINV) and the average return on two aggressive investment portfolios (S/HiINV and B/HiINV).	French (2019)
LBR	Labor income growth	The aggregate of salaries and wages component from earnings report of the firms listed on the NYSE, AMEX, and NASDAQ	Thomson Reuters - Datastream
WCR	Wealth-to-consumption ratio	Dividing wages with the consumption of consumer goods includes both durables and non-durables. The Consumption data are collected from Bloomberg database	Thomson Reuters - Datastream

Notes: All returns are in USD (US dollar). The datasets are expressed in monthly frequency. We follow Campbell (1996) to construct labor income growth measure of human capital.

Econometric methodology

Empirically, the cost of equity for the stock i may be expressed as

$$R_i - R_f = \alpha_i + \sum_{k=1}^n \delta_k \beta_{ik} + \varepsilon_i \quad (1)$$

Where $n = 1$ for the CAPM, $n = 3$ for FF three-factor model, $n = 5$ for FF five-factor model, and $n = 6$ for the equilibrium six-factor framework. α_i is the abnormal return for the stock i , δ_k is the proxy for the unobservable variable δ_k^0 , and ε_i is the white noise process.

Following the above framework, equation (2) is the empirical formulation of the CAPM takes the form

$$R_{it} - R_{ft} = \alpha_i + \beta_{1i} (RM - RF)_t + \varepsilon_{it} \quad (2)$$

Where $R_{it} - R_{ft}$ is the excess returns over the risk-free return of the portfolio i at the time t . β_1 captures the sensitivity of market portfolio at time t .

Equation (3) is the GMM formulation of equation (2).

$$R_{it} - R_{ft} = \alpha_{GMMi} + \beta_{GMM1i} (RM - RF)_t + \varepsilon_{it}^0 \quad (3)$$

Equation (4) is the empirical formula of FF three-factor model takes the form

$$R_{it} - R_{ft} = \alpha_i + \beta_{1i} (RM - RF)_t + \beta_{2i} SMB_t + \beta_{3i} HML_t + \varepsilon_{it} \quad (4)$$

Where $R_{it} - R_{ft}$ is the excess returns over the risk-free return of the portfolio i at the time t . β_1 , β_2 , and β_3 capture the sensitivity of market portfolio, size, and value, respectively at time t .

Equation (5) is the GMM formulation of equation (4).

$$R_{it} - R_{ft} = \alpha_{GMMi} + \beta_{GMM1i} (RM - RF)_t + \beta_{GMM2i} SMB_t + \beta_{GMM3i} HML_t + \varepsilon_{it}^0 \quad (5)$$

Equation (6) is the empirical formulation of FF five-factor model takes the form

$$R_{it} - R_{ft} = \alpha_i + \beta_{1i} (RM - RF)_t + \beta_{2i} SMB_t + \beta_{3i} HML_t + \beta_{4i} RMW_t + \beta_{5i} CMA_t + \varepsilon_{it} \quad (6)$$

Where $R_{it} - R_{ft}$ is the excess returns over the risk-free return of the portfolio i at the time t . β_1 , β_2 , β_3 , β_4 , and β_5 captures the sensitivity of market portfolio, size, value, profitability, and investment, respectively at time t .

Equation (7) is the GMM formulation of equation (6).

$$\begin{aligned} \mathbf{R}_i - \mathbf{R}_{ft} = & \alpha_{GMMi} + \beta_{GMM1i}(\mathbf{RM} - \mathbf{RF})_t + \beta_{GMM2i}\mathbf{SMB}_t + \beta_{GMM3i}\mathbf{HML}_t + \beta_{GMM4i}\mathbf{RMW}_t \\ & + \beta_{GMM5i}\mathbf{CMA}_t + \mathcal{E}_i^0 \end{aligned} \quad (7)$$

Equation (8) is the empirical formulation of equilibrium six-factor asset pricing model proposed in the study takes the form

$$\mathbf{R}_i - \mathbf{R}_{ft} = \alpha_i + \beta_{1i}\mathbf{LBR}_t + \beta_{2i}(\mathbf{RM} - \mathbf{RF})_t + \beta_{3i}\mathbf{SMB}_t + \beta_{4i}\mathbf{HML}_t + \beta_{5i}\mathbf{RMW}_t + \beta_{6i}\mathbf{CMA}_t + \varepsilon_{it} \quad (8)$$

Where $\mathbf{R}_i - \mathbf{R}_{ft}$ is the excess returns over the risk-free return of the portfolio i at the time t . $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5$, and β_6 captures the sensitivity of labor income growth measuring human capital, market portfolio, size, value, profitability, and investment, respectively at time t .

Equation (9) is the GMM formulation of equation (8).

$$\begin{aligned} \mathbf{R}_i - \mathbf{R}_{ft} = & \alpha_{GMMi} + \beta_{GMM1i}\mathbf{LBR}_t + \beta_{GMM2i}(\mathbf{RM} - \mathbf{RF})_t + \beta_{GMM3i}\mathbf{SMB}_t + \beta_{GMM4i}\mathbf{HML}_t \\ & + \beta_{GMM5i}\mathbf{RMW}_t + \beta_{GMM6i}\mathbf{CMA}_t + \mathcal{E}_i^0 \end{aligned} \quad (9)$$

GRS test

GRS test statistic proposed by Gibbons et al. (1989) is used to test the performance of the CAPM, FF three-factor, FF five-factor, and the equilibrium six-factor models, respectively.

$$\mathbf{GRS} \equiv \left(\frac{T - N - K}{N} \right) \left(1 + \hat{\mu}'\hat{\Omega}^{-1}\hat{\mu} \right)^{-1} \hat{\alpha}'\hat{\Sigma}^{-1}\hat{\alpha} : \mathbf{F}(N, T - N - K) \quad (10)$$

Where T is the total number of observations in the time-series, N is the number of portfolios. K is the number of factors in the asset pricing models (hence $K = 1$ for the CAPM, $K = 3$ for the FF three-factor model, $K = 5$ for the FF five-factor model, and $K = 6$ for the six-factor model). $\hat{\alpha}$ is an N by one vector of estimated alphas, $\hat{\Sigma}$ is an N by N matrix that holds the unbiased estimate of the residual variance-covariance matrix. $\hat{\mu}$ is a K by one vector of sample means of the portfolio's average returns, and $\hat{\Omega}$ is a K by K matrix that holds the unbiased estimate of the portfolios' covariance matrix. Assuming that the residual are independently and normally distributed, and uncorrelated with the returns on the model's factors, the GRS statistic follows an F-distribution with N degrees of freedom in the denominator and $T - N - K$ degrees in the numerator under the null of zero alphas. Along with GRS statistics, we calculate the following test statistics to test if all alphas are jointly equal to zero,

$$\mathbf{T} \left(1 + \hat{\mu}'\hat{\Omega}^{-1}\hat{\mu} \right)^{-1} \hat{\alpha}'\hat{\Sigma}^{-1}\hat{\alpha} : \chi_N^2 \quad (11)$$

This test statistics do not require the normality of error terms. Further, it follows an asymptotic χ^2 distribution with N degrees of freedom in the null hypothesis of zero alphas assuming homoscedasticity.

Relevance test for explanatory variables

Weak instrument occurs when the $((1)/(n))\mathbf{Z}'\mathbf{X}$ is close to zero. In line with Olea & Pflueger (2013), using the conventional F statistic for testing that all the coefficients in the regression $x_i = z_i'\pi + v_i$ (12) are 0. This specification is used to test the hypothesis that the instruments are weak. In other words, this is a test of the relevance of the instruments. Explicitly, we assess each explanatory variable used in the six-factor asset pricing model by estimating regression (12) on all the instruments. According to Olea & Pflueger (2013), if the resulting F statistic is below 24.00 for all the regressions (of explanatory variables), this indicates the possible weak instruments problem.

Conversely, if at least one of the F values (F -statistic) is above 24.00, then the instruments are robust. Note (from Table 2) all the F values are well-over 24.00. The instrumental variables coefficients represent the partial correlation with the explanatory variables. Beginning with the coefficient of Z_{LBR} on X_{LBR} and ending with the coefficient of Z_{CMA} on X_{CMA} , these diagonal coefficients are all close to 1.000 and possess significant t values (t -statistic), which indicates that particular instrument is highly related to its individual explanatory variable. The p -value (not reported) of the off-diagonal coefficients are relatively and statistically significant at 5% level (statistically significant for the utmost cases). We report the summary statistics of explanatory variables in the successive section.

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Table 2 Relevance test for explanatory variables

	α	Z_{LBR}	Z_{WCR}	Z_{RM-RF}	Z_{SMB}	Z_{HML}	Z_{RMW}	Z_{CMA}	F-statistic
X_{LBR}	-4.71E-13 <i>-18.417</i>	1.000 <i>6.94E+14</i>		9.81E-16 <i>1.411</i>	-1.44E-15 <i>-1.442</i>	-1.69E-15 <i>-1.313</i>	4.92E-16 <i>0.386</i>	3.59E-15 <i>1.940</i>	8.10E+28
X_{WCR}	0.00E+00 <i>0.000</i>		1.000 <i>1.15E+17</i>	2.40E-17 <i>7.248</i>	3.58E-17 <i>7.511</i>	-1.37E-17 <i>-2.236</i>	1.06E-16 <i>17.481</i>	0.00E+00 <i>0.000</i>	2.24E+33
X_{RM-RF}	0.00E+00 <i>0.000</i>	5.37E-18 <i>4.59E+00</i>		1.00E+00 <i>1.77E+18</i>	0.00E+00 <i>0.000</i>	0.00E+00 <i>0.000</i>	0.00E+00 <i>0.000</i>	0.00E+00 <i>0.000</i>	7.06E+35
X_{SMB}	3.68E-15 <i>15.023</i>	-2.10E-16 <i>-1.52E+01</i>		4.23E-17 <i>6.35E+00</i>	1.00E+00 <i>1.04E+17</i>	-4.76E-17 <i>-3.869</i>	4.75E-18 <i>0.389</i>	6.34E-17 <i>3.574</i>	2.32E+33
X_{HML}	0.000 <i>0.000</i>	2.69E-18 <i>0.190</i>		-2.12E-17 <i>-3.104</i>	-3.19E-17 <i>-3.257</i>	1.000 <i>7.95E+16</i>	0.000 <i>0.000</i>	0.000 <i>0.000</i>	2.07E+33

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	α	Z_{LBR}	Z_{WCR}	Z_{RM-RF}	Z_{SMB}	Z_{HML}	Z_{RMW}	Z_{CMA}	F-statistic
X_{RMW}	3.68E-15	-2.12E-16		4.23E-17	6.38E-17	-6.70E-17	1.000	-1.68E-16	2.88E+32
	<i>6.075</i>	<i>-6.221</i>		<i>2.568</i>	<i>2.694</i>	<i>-2.203</i>	<i>3.32E+16</i>	<i>-3.823</i>	
X_{CMA}	-2.21E-14	1.26E-15		-4.23E-17	-1.08E-16	6.70E-17	-1.78E-16	1.000	4.13E+31
	<i>-17.798</i>	<i>18.033</i>		<i>-1.254</i>	<i>-2.230</i>	<i>1.08E+00</i>	<i>-2.888</i>	<i>1.11E+16</i>	

Notes: The aggregate of 348 observations is used to calculate the descriptive statistics. The values with *italic* phase signify the *t*-statistic of the respective β coefficient of the instruments. The values with **bold** phase signify the *F* value (*F*-statistic) more than 24.00 for the respective regression of the explanatory variable.

Summary statistics of explanatory variables

The summary statistics of explanatory variables are reported in Table 3. The average excess value-weighted market returns (equity premium) over the one-month Treasury bill for the US is 0.656% per month ($t=2.714$). The size and value premiums are 0.102% ($t=0.625$) and 0.244% ($t=1.545$) per month respectively. Likewise, the profitability and investment premiums are 0.363% ($t=2.550$) and 0.320% ($t=2.060$) per month respectively for US. The average labor income growth and the wealth-to-consumption ratio, the aggregate measure of human capital are 17.620% ($t=174.890$) and 1.973% ($t=24.715$) per month respectively. The empirical estimation results of the asset pricing frameworks are reported in the following section.

Table 3 Summary statistics of the explanatory factors

	μ	σ	$t(\mu)$
RM-RF	0.656	4.507	2.714
SMB	0.102	3.047	0.625
HML	0.244	2.947	1.545
RMW	0.363	2.653	2.550
CMA	0.320	2.060	2.894
LNLBR	17.620	1.879	174.890
LNWCR	1.973	1.489	24.715

Notes: μ and σ are the mean and standard deviation of the explanatory factors. $t(\mu)$ is the ratio of Mean to its standard error.

Empirical estimation results of asset pricing framework

The GMM estimation results of FF portfolios of 2×3 , 5×5 , 10×10 sorts are shown in Table 4, $2 \times 4 \times 4$ sorts in Table 6, and Industry portfolios in Table 8. Similarly, the summary statistics of GRS test of FF portfolios of 2×3 , 5×5 , 10×10 sorts are reported in Table 5, $2 \times 4 \times 4$ sorts in Table 7, and Industry portfolios in Table 9.

Portfolios of 2×3 sorts

Panel A of Table 4 shows the GMM estimation result for 2×3 sorts of Size-B/M portfolios. The GMM estimation result infers that the human capital component of the six-factor model significantly priced the variation in excess return on three of 2×3 sorts of Size-B/M portfolios. Panel A of Table 5 presents the GRS test results of CAPM, FF three-factor, FF five-factor, and the six-factor models in approximating the excess return on 2×3 sorts of Size-B/M portfolios. The p -value of GRS test statistic rejects the null hypothesis of zero intercepts of CAPM, FF three-factor, and FF five-factor models for 2×3 sorts of Size-B/M portfolios. In line with our argument that human capital is a significant component of the six-factor asset pricing model, the p -value of GRS

test statistic unable to reject the null hypothesis of zero intercepts of the six-factor model. Following, the six-factor model passes the GRS test for 2×3 sorts of Size-B/M portfolios. The average AR^2 of the six-factor model is 0.972.

Panel A of Table 4 reports the GMM estimation result for 2×3 sorts of Size-OP portfolios. The GMM estimation result indicates that the human capital component of the six-factor model significantly priced the variation in excess return on three of 2×3 sorts of Size-OP portfolios. Panel A of Table 5 report the GRS test results of the variant asset pricing models and the p -value of GRS test statistic rejects the null hypothesis of zero intercepts of CAPM, FF three-factor, FF five-factor models along with the six-factor model for 2×3 sorts of Size-OP portfolios.

Panel A of Table 4 presents the GMM estimation result of 2×3 sorts of Size-Investment portfolios. The GMM estimation result infers that the human capital component of the six-factor model significantly priced the variation in excess return on five of 2×3 sorts of Size-Investment portfolios. Panel A of Table 5 present the GRS test results of the variant asset pricing models and the p -value of GRS test statistic rejects the null hypothesis of zero intercepts of CAPM, FF three-factor, and FF five-factor models albeit unable to reject the null hypothesis of the six-factor model for 2×3 sorts of Size-Investment portfolios. The average AR^2 of the six-factor model is 0.979.

Portfolios of 5×5 sorts

Panel B of Table 4 presents the GMM estimation result for 5×5 sorts of Size-B/M portfolios. The GMM estimation result indicates that the human capital component of the six-factor model significantly approximates the variation in excess return on twelve of 5×5 sorts of Size-B/M portfolios. Panel B of Table 5 shows the GRS test results of variant asset pricing models in pricing the excess return on 5×5 sorts of Size-B/M portfolios. The p -value of GRS test statistic rejects the null hypothesis of zero intercepts of CAPM, FF three-factor, and FF five-factor models for 5×5 sorts of Size-B/M portfolios. Moreover, the p -value of GRS test statistic unable to reject the null hypothesis of zero intercepts of the six-factor asset pricing model and hence passes the GRS test for 2×3 sorts of Size-B/M portfolios. The average AR^2 of the six-factor model is 0.915.

Panel B of Table 4 reports the GMM estimation result for 5×5 sorts of Size-OP portfolios. The GMM estimation result infers that the human capital component of the six-factor model significantly priced the variation in excess return on five of 5×5 sorts of Size-OP portfolios. Panel B of Table 5 reports the GRS test results of variant asset pricing models, and the p -value of GRS test statistic rejects the null hypothesis of zero intercepts of CAPM, FF three-factor, FF five-factor models along with the six-factor model for 5×5 sorts of Size-OP portfolios. The average AR^2 of the six-factor model is 0.926.

Panel B of Table 4 shows the GMM estimation result for 5×5 sorts of Size-Investment portfolios. The GMM estimation result indicates that the human capital component of the six-factor model significantly priced the variation in excess return on thirteen of 5×5 sorts of Size-Investment portfolios. Panel B of Table 5 present the GRS test results of variant asset pricing models and the p -value of GRS test statistic rejects the null hypothesis of zero intercepts of CAPM, FF three-factor, and FF five-factor models for 5×5 sorts of Size-Investment portfolios. Conversely, the p -value of GRS test statistic unable to reject the null hypothesis of zero intercepts of the six-factor model and passes the GRS test for 5×5 sorts of Size-Investment portfolios. The average AR^2 of the six-factor model is 0.699.

Portfolios of 10 × 10 sorts

Panel C of Table 4 shows the GMM estimation result for 10 × 10 sorts of Size-B/M portfolios. The GMM estimation result infers that the human capital component of the six-factor model significantly priced the variation in excess return on thirty-eight of 10 × 10 sorts of Size-B/M portfolios. Panel C of Table 5 reports the GRS test results of variant asset pricing models in pricing the excess return on 10 × 10 sorts of Size-B/M portfolios. The *p*-value of GRS test statistic rejects the null hypothesis of zero intercepts of CAPM, FF three-factor, and FF five-factor models albeit unable to reject the null hypothesis of the six-factor asset pricing model and hence passes the GRS test for 10 × 10 sorts of Size-B/M portfolios. The average AR^2 of the six-factor model is 0.791.

Panel C of Table 4 presents the GMM estimation result for 10 × 10 sorts of Size-OP portfolios. The result shows that the human capital component of the six-factor model significantly priced the variation in excess return on twenty-six of 10 × 10 sorts of Size-OP portfolios. Panel C of Table 5 presents the GRS test results of variant asset pricing models in pricing the excess return on 10 × 10 sorts of Size-OP portfolios. The *p*-value of GRS test statistic rejects the null hypothesis of zero intercepts of CAPM, FF three-factor, and five-factor models but accept the null hypothesis of zero intercepts of the six-factor asset pricing model. The six-factor model passes the GRS test convincingly for 10 × 10 sorts of Size-OP portfolios. The average AR^2 of the six-factor model is 0.806.

Panel C of Table 4 reports the GMM estimation result for 10 × 10 sorts of Size-Investment portfolios. The result infers that the human capital component of the six-factor model significantly priced the variation in excess return on twenty-three of 10 × 10 sorts of Size-Investment portfolios. Panel C of Table 5 shows the GRS test result of variant portfolios in approximating the excess return on 10 × 10 sorts of Size-Investment portfolios. The *p*-value of GRS test statistic rejects the null hypothesis of zero intercept of CAPM, FF three-factor, and five-factor models albeit unable to reject the null hypothesis of the six-factor model and hence passes the GRS test for 10 × 10 sorts of Size-Investment portfolios. The average AR^2 of the six-factor model is 0.810.

Briefly, the human capital component of the six-factor asset pricing model significantly priced the variation in excess return on 2 × 3, 5 × 5, 10 × 10 sorts of FF portfolios. Further, the six-factor asset pricing model outperforms the CAPM, FF three-factor, and FF five-factor models in asset return predictability.

Table 4 GMM estimates of six-factor asset pricing model to explain excess returns on FF portfolios of 2×3 , 5×5 , 10×10 sorts

		LBR	RM-RF	SMB	HML	RMW	CMA
<i>Panel A: FF portfolios from 2×3 sorts</i>							
2 × 3 sorts (6 Size-B/M portfolios)	GMM	-0.002	1.016	0.414	0.228	0.024	0.021
	$A z-\mu $	1.875	103.670	28.917	13.770	4.448	3.095
	# of significant portfolios	3	6	4	6	6	5
2 × 3 sorts (6 Size-OP portfolios)	GMM	-0.001	1.016	0.391	0.099	-0.017	-0.022
	$A z-\mu $	1.625	83.940	25.697	6.478	19.110	3.425
	# of significant portfolios	3	6	6	6	5	4
2 × 3 sorts (6 Size-Investment portfolios)	GMM	0.001	1.011	0.403	0.050	-0.007	0.095
	$A z-\mu $	2.565	89.052	26.257	3.492	5.445	12.015
	# of significant portfolios	5	6	6	1	6	6
<i>Panel B: FF portfolios from 5×5 sorts</i>							
5 × 5 sorts (25 Size-B/M portfolios)	GMM	-0.002	1.023	0.568	0.199	0.001	0.021
	$A z-\mu $	1.622	45.58	18.63	6.821	4.654	2.132
	# of significant portfolios	12	25	25	21	22	12
5 × 5 sorts (25 Size-OP portfolios)	GMM	0.0001	1.024	0.477	0.113	0.059	0.009
	$A z-\mu $	1.005	52.227	16.529	4.337	10.054	2.035
	# of significant portfolios	5	25	25	21	24	13
5 × 5 sorts (25 Size-Investment portfolios)	GMM	0.0105	1.003	0.545	0.116	-0.005	0.121
	$A z-\mu $	1.971	35.285	13.925	2.730	3.065	4.166
	# of significant portfolios	13	25	25	16	17	20

Panel C: FF portfolios from 10 × 10 sorts

10 × 10 sorts (100 Size-B/M portfolios)	GMM	-0.008	1.035	0.540	0.245	0.036	0.013
	<i>A z-μ </i>	<i>1.312</i>	<i>25.949</i>	<i>10.794</i>	<i>4.376</i>	<i>3.508</i>	<i>1.564</i>
	# of significant portfolios	38	100	93	83	75	38
10 × 10 sorts (100 Size-OP portfolios)	GMM	-0.0002	1.012	0.543	0.154	0.080	0.011
	<i>A z-μ </i>	<i>1.112</i>	<i>31.020</i>	<i>12.235</i>	<i>3.119</i>	<i>5.594</i>	<i>1.408</i>
	# of significant portfolios	26	100	95	69	87	36
10 × 10 sorts (100 Size-Investment portfolios)	GMM	0.002	1.015	0.562	0.115	0.030	0.102
	<i>A z-μ </i>	<i>1.174</i>	<i>29.706</i>	<i>11.649</i>	<i>2.590</i>	<i>3.410</i>	<i>2.898</i>
	# of significant portfolios	23	100	94	61	76	65

Notes: The main results appearing in this table are averages of 2 × 3, 5 × 5, 10 × 10 sorts of FF portfolios. *A|z-μ|* is the average absolute z-mean for a set of regressions. z-statistics are in italics and are HAC (Newey & West, 1987) corrected for GMM. The number of significant portfolios at the 5 and 10 percent level are labeled by # of significant portfolios. The GMM estimate results of CAPM, FF three-factor, and FF five-factor models are not reported here but available with the authors upon request.

Table 5 Summary statistics of asset pricing tests for FF portfolios of 2×3 , 5×5 , 10×10 sorts

	No. of FF portfolios	Asset pricing model	Model factors	<i>GRS</i>	<i>p(GRS)</i>	$A a_i $	AR^2
<i>Panel A: FF portfolios from 2×3 sorts</i>							
2×3 sorts	6 Size-B/M	CAPM	<i>RM-RF</i>	6.657	0.000	0.187	0.786
2×3 sorts	6 Size-B/M	FF three-factor model	<i>RM-RF SMB HML</i>	6.413	0.000	0.130	0.966
2×3 sorts	6 Size-B/M	FF five-factor model	<i>RM-RF SMB HML RMW CMA</i>	3.391	0.002	0.079	0.971
2×3 sorts	6 Size-B/M	Six-factor model	<i>LBR RM-RF SMB HML RMW CMA</i>	1.382	0.220	0.260	0.972
2×3 sorts	6 Size-OP	CAPM	<i>RM-RF</i>	4.201	0.000	0.215	0.840
2×3 sorts	6 Size-OP	FF three-factor model	<i>RM-RF SMB HML</i>	6.153	0.000	0.180	0.950
2×3 sorts	6 Size-OP	FF five-factor model	<i>RM-RF SMB HML RMW CMA</i>	4.685	0.000	0.055	0.979
2×3 sorts	6 Size-OP	Six-factor model	<i>LBR RM-RF SMB HML RMW CMA</i>	2.561	0.019	0.421	0.979
2×3 sorts	6 Size-Investment	CAPM	<i>RM-RF</i>	7.802	0.000	0.215	0.827
2×3 sorts	6 Size-Investment	FF three-factor model	<i>RM-RF SMB HML</i>	8.549	0.000	0.139	0.960
2×3 sorts	6 Size-Investment	FF five-factor model	<i>RM-RF SMB HML RMW CMA</i>	3.970	0.000	0.102	0.980
2×3 sorts	6 Size-Investment	Six-factor model	<i>LBR RM-RF SMB HML RMW CMA</i>	1.200	0.305	0.206	0.980
<i>Panel B: FF portfolios from 5×5 sorts</i>							
5×5 sorts	25 Size-B/M	CAPM	<i>RM-RF</i>	4.964	0.000	0.214	0.723
5×5 sorts	25 Size-B/M	FF three-factor model	<i>RM-RF SMB HML</i>	5.036	0.000	0.141	0.905
5×5 sorts	25 Size-B/M	FF five-factor model	<i>RM-RF SMB HML RMW CMA</i>	4.253	0.000	0.133	0.914
5×5 sorts	25 Size-B/M	Six-factor model	<i>LBR RM-RF SMB HML RMW CMA</i>	0.773	0.775	0.523	0.915
5×5 sorts	25 Size-OP	CAPM	<i>RM-RF</i>	21.967	0.000	0.225	0.780
5×5 sorts	25 Size-OP	FF three-factor model	<i>RM-RF SMB HML</i>	28.284	0.000	0.166	0.899
5×5 sorts	25 Size-OP	FF five-factor model	<i>RM-RF SMB HML RMW CMA</i>	25.620	0.000	0.080	0.926
5×5 sorts	25 Size-OP	Six-factor model	<i>LBR RM-RF SMB HML RMW CMA</i>	21.485	0.000	0.451	0.926
5×5 sorts	25 Size-Investment	CAPM	<i>RM-RF</i>	3.416	0.000	0.260	0.557
5×5 sorts	25 Size-Investment	FF three-factor model	<i>RM-RF SMB HML</i>	3.346	0.000	0.163	0.685
5×5 sorts	25 Size-Investment	FF five-factor model	<i>RM-RF SMB HML RMW CMA</i>	2.514	0.000	0.106	0.696
5×5 sorts	25 Size-Investment	Six-factor model	<i>LBR RM-RF SMB HML RMW CMA</i>	1.125	0.311	2.662	0.699

Panel C: FF portfolios from 10 × 10 sorts

10 × 10 sorts	100 Size-B/M	CAPM	<i>RM-RF</i>	2.809	0.000	0.396	0.620
10 × 10 sorts	100 Size-B/M	FF three-factor model	<i>RM-RF SMB HML</i>	2.883	0.000	0.335	0.779
10 × 10 sorts	100 Size-B/M	FF five-factor model	<i>RM-RF SMB HML RMW CMA</i>	2.491	0.000	0.315	0.791
10 × 10 sorts	100 Size-B/M	Six-factor model	<i>LBR RM-RF SMB HML RMW CMA</i>	0.728	0.965	1.428	0.791
10 × 10 sorts	100 Size-OP	CAPM	<i>RM-RF</i>	1.876	0.000	0.272	0.663
10 × 10 sorts	100 Size-OP	FF three-factor model	<i>RM-RF SMB HML</i>	1.822	0.000	0.217	0.782
10 × 10 sorts	100 Size-OP	FF five-factor model	<i>RM-RF SMB HML RMW CMA</i>	1.614	0.001	0.171	0.804
10 × 10 sorts	100 Size-OP	Six-factor model	<i>LBR RM-RF SMB HML RMW CMA</i>	1.112	0.254	1.222	0.806
10 × 10 sorts	100 Size-Investment	CAPM	<i>RM-RF</i>	2.039	0.000	0.296	0.658
10 × 10 sorts	100 Size-Investment	FF three-factor model	<i>RM-RF SMB HML</i>	2.196	0.000	0.217	0.794
10 × 10 sorts	100 Size-Investment	FF five-factor model	<i>RM-RF SMB HML RMW CMA</i>	1.864	0.000	0.183	0.809
10 × 10 sorts	100 Size-Investment	Six-factor model	<i>LBR RM-RF SMB HML RMW CMA</i>	1.190	0.142	1.287	0.810

Notes: The GRS tests whether all intercepts in the six regressions are zero. $p(GRS)$ is the corresponding probability value of GRS test statistic. $A|a_i|$ is the average absolute intercept for a set of regressions. AR^2 , the average of the regression R^2 , adjusted for degrees of freedom.

Portfolios of $2 \times 4 \times 4$ sorts

Table 6 reports the GMM estimation result for $2 \times 4 \times 4$ sorts of Size-B/M-OP portfolios. The GMM estimation result shows that the human capital component of the six-factor model significantly priced the variation in excess return on eleven of $2 \times 4 \times 4$ sorts of Size-B/M-OP portfolios. Following, Table 7 presents the GRS test results of CAPM, FF three-factor, FF five-factor, and the six-factor asset pricing models in pricing the excess returns on $2 \times 4 \times 4$ sorts of Size-B/M-OP portfolios. The p -value of GRS test statistic rejects the null hypothesis of zero intercepts of CAPM, FF three-factor, and FF five-factor models but unable to reject the null hypothesis of the six-factor asset pricing model and passes the GRS test convincingly for $2 \times 4 \times 4$ sorts of Size-B/M-OP portfolios. The average AR^2 of the six-factor model is 0.858.

The GMM estimation result (Table 6) for $2 \times 4 \times 4$ sorts of Size-B/M-Investment portfolios infers that the human capital component of the six-factor model significantly priced the variation in excess return on nine of $2 \times 4 \times 4$ sorts of Size-B/M-Investment portfolios. Following, Table 7 shows the GRS test result of the variant models in pricing the excess return on $2 \times 4 \times 4$ sorts of Size-B/M-Investment portfolios. The p -value of GRS test statistic rejects the null hypothesis of zero intercepts of CAPM, FF three-factor, and FF five-factor models albeit unable to reject the null hypothesis of the six-factor asset pricing model and pass the GRS test for $2 \times 4 \times 4$ sorts of Size-B/M-Investment portfolios. The average AR^2 of the six-factor model is 0.882.

Table 6 presents the GMM estimation result for $2 \times 4 \times 4$ sorts of Size-OP-Investment portfolios. The GMM estimation result infers that the human capital component of the six-factor model significantly priced the variation in excess return on thirteen of $2 \times 4 \times 4$ sorts of Size-OP-Investment portfolios. Following, Table 7 presents the GRS test results of variant asset pricing models in approximating the excess returns on $2 \times 4 \times 4$ sorts of Size-OP-Investment portfolios. The p -value of GRS test statistic rejects the null hypothesis of zero intercepts of CAPM, FF three-factor, and FF five-factor models but unable to reject the null hypothesis of the six-factor asset pricing model and passes the GRS test convincingly for $2 \times 4 \times 4$ sorts of Size-OP-Investment portfolios. The average AR^2 of the six-factor model is 0.883.

Concisely, the human capital component of the six-factor asset pricing model significantly priced the variation in excess return on $2 \times 4 \times 4$ sorts of Size-B/M-OP, Size-B/M-Investment, and Size-OP-Investment portfolios. Further, the six-factor asset pricing model outclasses the CAPM, FF three-factor, and FF five-factor models in asset return predictability.

Table 6 GMM estimates of six-factor asset pricing model to explain excess returns on FF portfolios of $2 \times 4 \times 4$ sorts

		LBR	RM-RF	SMB	HML	RMW	CMA
$2 \times 4 \times 4$ sorts (32 Size-B/M-OP portfolios)	GMM	0.0006	1.036	0.419	0.233	0.096	0.015
	$A z-\mu $	1.228	36.951	11.743	5.972	5.343	1.936
	# of significant portfolios	11	32	22	26	28	15
$2 \times 4 \times 4$ sorts (32 Size-B/M-Investment portfolios)	GMM	-0.001	1.019	0.421	0.223	0.096	0.127
	$A z-\mu $	1.386	38.123	13.470	6.142	3.887	4.342
	# of significant portfolios	9	25	23	25	21	23
$2 \times 4 \times 4$ sorts (32 Size-OP-Investment portfolios)	GMM	-0.0002	1.014	0.402	0.115	0.056	0.085
	$A z-\mu $	1.408	39.008	13.024	4.203	6.651	3.832
	# of significant portfolios	13	32	22	27	29	27

Notes: The main results appearing in this table are averages of the FF portfolios of $2 \times 4 \times 4$ sorts. $A|z-\mu|$ is the average absolute z-mean for a set of regressions. z-statistics are in italics and are HAC (Newey & West, 1987) corrected for GMM. The number of significant portfolios at the 5 and 10 percent level are labeled by # of significant portfolios.

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Table 7 Summary statistics of asset pricing tests for FF portfolios of $2 \times 4 \times 4$ sorts

	No. of FF portfolios	Asset pricing model	Model factors	<i>GRS</i>	$p(\text{GRS})$	$A a_i $	AR^2
$2 \times 4 \times 4$ sorts	32 Size-B/M-OP	CAPM	<i>RM-RF</i>	2.707	0.000	0.270	0.681
$2 \times 4 \times 4$ sorts	32 Size-B/M-OP	FF three-factor model	<i>RM-RF SMB HML</i>	2.734	0.000	0.170	0.837
$2 \times 4 \times 4$ sorts	32 Size-B/M-OP	FF five-factor model	<i>RM-RF SMB HML RMW CMA</i>	2.184	0.000	0.142	0.858
$2 \times 4 \times 4$ sorts	32 Size-B/M-OP	Six-factor model	<i>LBR RM-RF SMB HML RMW CMA</i>	1.465	0.054	0.902	0.858
$2 \times 4 \times 4$ sorts	32 Size-B/M-Investment	CAPM	<i>RM-RF</i>	2.803	0.000	0.211	0.705
$2 \times 4 \times 4$ sorts	32 Size-B/M-Investment	FF three-factor model	<i>RM-RF SMB HML</i>	2.641	0.000	0.172	0.865
$2 \times 4 \times 4$ sorts	32 Size-B/M-Investment	FF five-factor model	<i>RM-RF SMB HML RMW CMA</i>	1.861	0.004	0.117	0.882
$2 \times 4 \times 4$ sorts	32 Size-B/M-Investment	Six-factor model	<i>LBR RM-RF SMB HML RMW CMA</i>	0.541	0.980	0.511	0.882
$2 \times 4 \times 4$ sorts	32 Size-OP-Investment	CAPM	<i>RM-RF</i>	3.737	0.000	0.289	0.729
$2 \times 4 \times 4$ sorts	32 Size-OP-Investment	FF three-factor model	<i>RM-RF SMB HML</i>	3.859	0.000	0.222	0.855
$2 \times 4 \times 4$ sorts	32 Size-OP-Investment	FF five-factor model	<i>RM-RF SMB HML RMW CMA</i>	2.793	0.000	0.144	0.883
$2 \times 4 \times 4$ sorts	32 Size-OP-Investment	Six-factor model	<i>LBR RM-RF SMB HML RMW CMA</i>	1.308	0.129	0.772	0.883

Notes: The GRS tests whether all intercepts in the six regressions are zero. $p(\text{GRS})$ is the corresponding probability value of GRS test statistic. $A|a_i|$ is the average absolute intercept for a set of regressions. AR^2 , the average of the regression R^2 , adjusted for degrees of freedom.

FF Industry portfolios of variant sets

Table 8 presents the GMM estimation result of 5, 10, 12, 17, 30, 48, and 49 FF Industry portfolios whereas Panel A, B, C, D, E, F, and G of Table 9 shows the GRS test result of variant models for 5, 10, 12, 17, 30, 48, and 49 FF Industry portfolios respectively.

Table 8 reports the GMM estimation result for 5 Industry portfolios, and the estimation result infers that the human capital component of the six-factor model significantly priced the variation in excess return on four of 5 Industry portfolios. Following, panel A of Table 9 shows the GRS test result of CAPM, FF three-factor, FF five-factor, and the six-factor asset pricing models in pricing the excess returns on 5 Industry portfolios. The p -value of GRS test statistic rejects the null hypothesis of zero intercepts of CAPM, FF three-factor, and FF five-factor models but unable to reject the null hypothesis of the six-factor model and hence passes the GRS test. The average AR^2 of the six-factor model is 0.745.

The GMM result of 10 Industry portfolios indicates that the human capital measure of the six-factor model significantly priced the variation in excess return on five of 10 Industry portfolios. Panel B of Table 9 presents the GRS test result of the variant models in pricing the excess returns on 10 Industry portfolios. The p -value of GRS test statistic rejects the null hypothesis of zero intercepts of CAPM, FF three-factor, and FF five-factor models albeit unable to reject the null hypothesis of the six-factor model and pass the GRS test. The average AR^2 of the six-factor model is 0.699.

The GMM result of 12 Industry portfolio infers that the human capital measure of the six-factor model significantly approximates the variation in excess return on five of 12 Industry portfolios. Panel C of Table 9 shows the GRS test result of the variant models in pricing the excess return on 12 Industry portfolios. The p -value of GRS test statistic rejects the null hypothesis of zero intercepts of CAPM, FF three-factor, and FF five-factor models except for the six-factor model that passes the GRS test. The average AR^2 of the six-factor model is 0.713.

Table 8 presents the GMM estimation results for 17 and 30 Industry portfolios, which indicates that the human capital component of the six-factor model significantly captures the variation in excess return on four of 17 and ten of 30 Industry portfolios. Following, panel D and E of Table 9 reports the GRS test result of the variant models in pricing the excess return on 17 and 30 Industry portfolios respectively. The p -value of GRS test statistic rejects the null hypothesis of zero intercepts of FF three-factor and five-factor models except for CAPM and the six-factor model and both of which passes the GRS test for 17 and 30 Industry portfolios. The average AR^2 of the six-factor model is 0.677 for 17 and 0.632 for 30 Industry portfolios.

Table 8 reports the GMM estimation results for 48 and 49 Industry portfolios, which infers that the human capital component of the six-factor model significantly priced the variation in excess return on twenty of 48 and twenty-one of 49 Industry portfolios. Following, panel F and G of Table 9 shows the GRS test result of the variant models in pricing the excess return on 48 and 49 Industry portfolios respectively. The p -value of GRS test statistic rejects the null hypothesis of zero intercepts of FF three-factor and five-factor models albeit unable to reject the null hypothesis for CAPM and the six-factor model and both of which passes the GRS test for 48 and 49 Industry portfolios. The average AR^2 of the six-factor model is 0.597 for 48 and 0.600 for 49 Industry portfolios.

Succinctly, the human capital measure of the six-factor asset pricing model significantly priced the variation in excess return on 5, 10, 12, 17, 30, 48, and 49 FF Industry portfolios. Further, the six-factor asset pricing model passes the GRS test of Gibbons et al. (1989) and outperforms

the FF three-factor and FF five-factor models in asset return predictability with the exception CAPM, which passes the GRS test for 17, 30, 48, and 49 FF Industry portfolios.

In the successive section, we report the results of additional tests for robustness.

Table 8 GMM estimates of six-factor asset pricing model to explain excess returns on FF Industry portfolios

		LBR	RM-RF	SMB	HML	RMW	CMA
5 Industry portfolios	GMM	-0.0007	0.997	-0.017	-0.014	0.148	0.108
	$A z-\mu $	2.168	31.898	2.050	4.328	4.874	2.254
	# of significant portfolios	4	5	2	3	5	5
10 Industry portfolios	GMM	-0.001	0.985	0.011	0.068	0.174	0.145
	$A z-\mu $	1.409	24.791	2.117	3.340	3.836	2.155
	# of significant portfolios	4	10	6	6	7	7
12 Industry portfolios	GMM	-0.0046	1.001	0.027	0.092	0.186	0.136
	$A z-\mu $	1.486	24.099	2.195	2.954	3.778	1.8625
	# of significant portfolios	5	12	6	7	7	7
17 Industry portfolios	GMM	-0.009	1.053	0.156	0.179	0.236	0.091
	$A z-\mu $	1.251	26.524	2.877	2.969	4.917	1.315
	# of significant portfolios	4	18	12	12	13	4
30 Industry portfolios	GMM	-0.010	1.078	0.179	0.140	0.295	0.138
	$A z-\mu $	1.402	20.386	2.583	2.670	4.204	1.849
	# of significant portfolios	10	30	19	16	22	

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		LBR	RM-RF	SMB	HML	RMW	CMA
48 Industry portfolios	GMM	-0.011	1.071	0.256	0.164	0.310	0.108
	<i>A z-μ </i>	1.380	17.646	3.196	2.693	4.297	1.766
	# of significant portfolios	20	48	35	27	38	24
49 Industry portfolios	GMM	-0.010	1.072	0.255	0.155	0.307	0.102
	<i>A z-μ </i>	1.382	17.875	3.202	2.626	4.215	1.715
	# of significant portfolios	21	49	36	27	38	24

Notes: The main results appearing in this table are averages of the FF Industry portfolios. *A|z- μ |* is the average absolute z-mean for a set of regressions. z-statistics are in italics and are HAC (Newey & West, 1987) corrected for GMM. The number of significant portfolios at the 5 and 10 percent level are labeled by # of significant portfolios. The GMM estimation results of CAPM, FF three-factor, and five-factor models are not reported here but available with the authors upon request.

Table 9 Summary statistics of asset pricing tests for FF Industry portfolios

	Model factors	<i>GRS</i>	<i>p(GRS)</i>	$A a_i $	AR^2
<u><i>Panel A: FF 5 Industry portfolios</i></u>					
CAPM	<i>RM-RF</i>	3.063	0.010	0.190	0.745
FF three-factor model	<i>RM-RF SMB HML</i>	4.788	0.000	0.196	0.791
FF five-factor model	<i>RM-RF SMB HML RMW CMA</i>	3.773	0.002	0.196	0.823
Six-factor model	<i>LBR RM-RF SMB HML RMW CMA</i>	1.130	0.343	0.807	0.824
<u><i>Panel B: FF 10 Industry portfolios</i></u>					
CAPM	<i>RM-RF</i>	1.888	0.045	0.215	0.611
FF three-factor model	<i>RM-RF SMB HML</i>	3.217	0.000	0.218	0.664
FF five-factor model	<i>RM-RF SMB HML RMW CMA</i>	2.391	0.009	0.183	0.698
Six-factor model	<i>LBR RM-RF SMB HML RMW CMA</i>	0.678	0.744	0.904	0.699
<u><i>Panel C: FF 12 Industry portfolios</i></u>					
CAPM	<i>RM-RF</i>	2.037	0.020	0.207	0.627
FF three-factor model	<i>RM-RF SMB HML</i>	3.102	0.000	0.211	0.680
FF five-factor model	<i>RM-RF SMB HML RMW CMA</i>	2.386	0.005	0.189	0.696
Six-factor model	<i>LBR RM-RF SMB HML RMW CMA</i>	0.668	0.781	0.843	0.713
<u><i>Panel D: FF 17 Industry portfolios</i></u>					
CAPM	<i>RM-RF</i>	1.208	0.255	0.187	0.585
FF three-factor model	<i>RM-RF SMB HML</i>	1.923	0.015	0.181	0.640
FF five-factor model	<i>RM-RF SMB HML RMW CMA</i>	1.565	0.071	0.207	0.676
Six-factor model	<i>LBR RM-RF SMB HML RMW CMA</i>	0.617	0.878	0.885	0.677
<u><i>Panel E: FF 30 Industry portfolios</i></u>					
CAPM	<i>RM-RF</i>	1.102	0.330	0.201	0.546
FF three-factor model	<i>RM-RF SMB HML</i>	1.707	0.013	0.221	0.596

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	Model factors	<i>GRS</i>	<i>p(GRS)</i>	$A a_i $	AR^2
FF five-factor model	<i>RM-RF SMB HML RMW CMA</i>	1.742	0.011	0.241	0.632
Six-factor model	<i>LBR RM-RF SMB HML RMW CMA</i>	0.694	0.885	1.208	0.632
<i>Panel F: FF 48 Industry portfolios</i>					
CAPM	<i>RM-RF</i>	1.051	0.388	0.200	0.506
FF three-factor model	<i>RM-RF SMB HML</i>	1.450	0.034	0.216	0.562
FF five-factor model	<i>RM-RF SMB HML RMW CMA</i>	1.556	0.015	0.277	0.596
Six-factor model	<i>LBR RM-RF SMB HML RMW CMA</i>	1.031	0.422	1.647	0.597
<i>Panel G: FF 49 Industry portfolios</i>					
CAPM	<i>RM-RF</i>	1.093	0.321	0.202	0.510
FF three-factor model	<i>RM-RF SMB HML</i>	1.577	0.012	0.219	0.565
FF five-factor model	<i>RM-RF SMB HML RMW CMA</i>	1.546	0.015	0.281	0.599
Six-factor model	<i>LBR RM-RF SMB HML RMW CMA</i>	1.084	0.334	1.667	0.600

Notes: The GRS tests whether all intercepts in the six regressions are zero. *p(GRS)* is the corresponding probability value of GRS test statistic. $A|a_i|$ is the average absolute intercept for a set of regressions. AR^2 , the average of the regression R^2 , adjusted for degrees of freedom.

Additional tests for robustness

We use the wealth-to-consumption ratio (WCR) of Lustig et al. (2013) as an alternative measure of human capital. We substitute LBR with WCR as the measure of human capital in equation (8) representing the equilibrium six-factor asset pricing model, which yields

$$R_{it} - R_{ft} = \alpha_i + \beta_{1i}WCR_t + \beta_{2i}(RM - RF)_t + \beta_{3i}SMB_t + \beta_{4i}HML_t + \beta_{5i}RMW_t + \beta_{6i}CMA_t + \varepsilon_{it} \quad (12)$$

We use equations (10) and (11) to evaluate the statistical and economic significance of equation (12) in asset return predictability. We employ the excess return on FF portfolios of 2×3 , 5×5 , 10×10 sorts, $2 \times 4 \times 4$ sorts, and the Industry portfolios to implement the above proposition.

Table 10 reports the GRS test results of the six-factor asset pricing model in pricing the excess return on 2×3 , 5×5 , 10×10 sorts of FF portfolios. Panel A, B, and C of Table 10 shows the GRS test results of the six-factor asset pricing model for 2×3 , 5×5 , 10×10 sorts of FF portfolios respectively. The p -value of GRS test statistic unable to reject the null hypothesis of zero intercepts of the six-factor asset pricing model for 2×3 and 10×10 sorts of FF portfolios with the exception for 5×5 sorts of FF portfolios. Hence, the six-factor asset pricing model passes the GRS test for 2×3 and 10×10 sorts of FF portfolios.

Table 11 presents the GRS test results of the six-factor asset pricing model in approximating the excess return on FF portfolios of $2 \times 4 \times 4$ sorts. The p -value of GRS test statistic unable to reject the null hypothesis of zero intercepts of the six-factor asset pricing model for FF portfolios of $2 \times 4 \times 4$ sorts on Size-B/M-Investment and passes the GRS test. Conversely, the p -value of GRS test statistic rejects the null hypothesis of zero intercepts of the six-factor asset pricing model and hence underperform for FF portfolios of $2 \times 4 \times 4$ sorts on Size-B/M-OP and Size-OP-Investment.

Table 12 shows the GRS test results of the six-factor asset pricing model in pricing the excess return on 5, 10, 12, 17, 30, 48, and 49 FF Industry portfolios. The p -value of GRS test statistic unable to reject the null hypothesis of zero intercepts of the six-factor asset pricing model for 5, 10, 12, 17, 30, and 48 FF Industry portfolios and hence passes the GRS test. Conversely, a p -value of GRS test statistic rejects the null hypothesis of zero intercepts of the six-factor asset pricing model for 49 FF Industry portfolios.

The robustness test results further confirm the performance of the equilibrium six-factor asset pricing model in approximating the variation in return predictability. In other words, the parameter estimation of the six-factor model is robust to the alternative definitions of the human capital component. Conclusively, the empirical results offer favorable evidence in support of the equilibrium six-factor asset pricing model, which outperforms the CAPM, FF three-factor, and FF five-factor models in return predictability.

The successive section accompanies the empirical interpretation of the results and the summary of the study.

Table 10 Summary statistics of asset pricing tests (with WCR measuring human capital) for FF portfolios of 2×3 , 5×5 , and 10×10 sorts

	No. of FF portfolios	Asset pricing model	Model factors	<i>GRS</i>	<i>p(GRS)</i>	$A a_i $	AR^2
<i>Panel A: FF 2 × 3 sorted portfolios</i>							
2 × 3 sorted	6 Size-B/M	Six-factor model	<i>WCR RM-RF SMB HML RMW CMA</i>	3.226	0.004	0.566	0.972
2 × 3 sorted	6 Size-OP	Six-factor model	<i>WCR RM-RF SMB HML RMW CMA</i>	5.084	0.000	0.096	0.979
2 × 3 sorted	6 Size-Investment	Six-factor model	<i>WCR RM-RF SMB HML RMW CMA</i>	1.938	0.074	0.098	0.980
<i>Panel B: FF 5 × 5 sorted portfolios</i>							
5 × 5 sorted	25 Size-B/M	Six-factor model	<i>WCR RM-RF SMB HML RMW CMA</i>	2.306	0.000	0.149	0.915
5 × 5 sorted	25 Size-OP	Six-factor model	<i>WCR RM-RF SMB HML RMW CMA</i>	48.626	0.000	0.111	0.926
5 × 5 sorted	25 Size-Investment	Six-factor model	<i>WCR RM-RF SMB HML RMW CMA</i>	1.700	0.000	0.021	0.699
<i>Panel C: FF 10 × 10 sorted portfolios</i>							
10 × 10 sorted	100 Size-B/M	Six-factor model	<i>WCR RM-RF SMB HML RMW CMA</i>	1.194	0.138	0.239	0.791
10 × 10 sorted	100 Size-OP	Six-factor model	<i>WCR RM-RF SMB HML RMW CMA</i>	0.113	0.251	0.192	0.805
10 × 10 sorted	100 Size-Investment	Six-factor model	<i>WCR RM-RF SMB HML RMW CMA</i>	1.232	0.099	0.258	0.810

Notes: The GRS tests whether all intercepts in the six regressions are zero. *p(GRS)* is the corresponding probability value of GRS test statistic. $A|a_i|$ is the average absolute intercept for a set of regressions. AR^2 , the average of the regression R^2 , adjusted for degrees of freedom.

Table 11 Summary statistics of asset pricing tests (with WCR measuring human capital) for FF portfolios of $2 \times 4 \times 4$ sorts

	No. of FF portfolios	Asset pricing model	Model factors	<i>GRS</i>	<i>p(GRS)</i>	$A a_i $	AR^2
$2 \times 4 \times 4$ sorted	32 Size-B/M-OP	Six-factor model	<i>WCR RM-RF SMB HML RMW CMA</i>	1.950	0.002	0.199	0.858
$2 \times 4 \times 4$ sorted	32 Size-B/M-Investment	Six-factor model	<i>WCR RM-RF SMB HML RMW CMA</i>	0.756	0.828	0.138	0.882
$2 \times 4 \times 4$ sorted	32 Size-OP-Investment	Six-factor model	<i>WCR RM-RF SMB HML RMW CMA</i>	2.444	0.000	0.197	0.883

Notes: The GRS tests whether all intercepts in the six regressions are zero. *p(GRS)* is the corresponding probability value of GRS test statistic. $A|a_i|$ is the average absolute intercept for a set of regressions. AR^2 , the average of the regression R^2 , adjusted for degrees of freedom.

Table 12 Summary statistics of asset pricing tests (with WCR measuring human capital) for FF Industry portfolios

	Asset pricing model	Model factors	<i>GRS</i>	<i>p(GRS)</i>	$A a_i $	AR^2
5 Industry portfolios	Six-factor model	<i>WCR RM-RF SMB HML RMW CMA</i>	1.835	0.105	0.171	0.824
10 Industry portfolios	Six-factor model	<i>WCR RM-RF SMB HML RMW CMA</i>	0.953	0.484	0.168	0.699
12 Industry portfolios	Six-factor model	<i>WCR RM-RF SMB HML RMW CMA</i>	0.677	0.772	0.166	0.713
17 Industry portfolios	Six-factor model	<i>WCR RM-RF SMB HML RMW CMA</i>	0.825	0.663	0.203	0.677
30 Industry portfolios	Six-factor model	<i>WCR RM-RF SMB HML RMW CMA</i>	0.974	0.508	0.272	0.632
48 Industry portfolios	Six-factor model	<i>WCR RM-RF SMB HML RMW CMA</i>	1.318	0.088	0.347	0.597
49 Industry portfolios	Six-factor model	<i>WCR RM-RF SMB HML RMW CMA</i>	1.403	0.047	0.354	0.600

Notes: The GRS tests whether all intercepts in the six regressions are zero. $p(GRS)$ is the corresponding probability value of GRS test statistic. $A|a_i|$ is the average absolute intercept for a set of regressions. AR^2 , the average of the regression R^2 , adjusted for degrees of freedom.

Empirical interpretation and summary

The present study develops an intertemporal framework where human capital component and the common factors jointly estimate the risks associated with an asset. Primarily, we examine the joint dynamics of the human capital component and common factors in asset return predictability. In the second stage, we investigate whether the human capital component is an unaccounted pricing factor of FF five-factor asset pricing model. In other words, Is human capital the sixth factor of FF five-factor asset pricing model?

The human capital component, market portfolio, size, value, profitability, and investment are the pricing factors in the intertemporal six-factor asset pricing framework developed in the study. The study period covers thirty years of time-series data. We include the frequently used asset pricing models that are well documented in the asset pricing literature, CAPM, FF three-factor model, FF five-factor model, along with the equilibrium six-factor model to capture the patterns in excess return on FF portfolios of 2×3 , 5×5 , 10×10 sorts, $2 \times 4 \times 4$ sorts, and FF Industry portfolios. We use GMM estimation for estimating the parameters of the variant asset pricing models and GRS test statistics for evaluating the statistical and economic performance of the asset pricing models.

The conclusions are drawn in three phases. First, the GMM estimation result infers that the human capital component of the equilibrium six-factor asset pricing framework significantly priced the variation in excess return on the FF portfolios of 2×3 , 5×5 , 10×10 sorts, $2 \times 4 \times 4$ sorts, and FF Industry portfolios. Furthermore, the empirical results reveal that the sensitivity of the human capital component priced separately in the presence of the market portfolio and the common factors. Second, the GRS test of Gibbons et al. (1989) rejects the null hypothesis of zero intercepts of CAPM, FF three-factor model, and FF five-factor model across the FF portfolios of variant sorts and for FF Industry portfolios, and hence rejected. In turn, the equilibrium six-factor asset pricing model pass the GRS test for FF portfolios of 2×3 , 5×5 , 10×10 sorts, $2 \times 4 \times 4$ sorts, and for FF Industry portfolios. Thus, the six-factor asset pricing model outperformed the variant asset pricing models in the return predictability. Third, the GMM estimation and GRS test results indicate that the proposed equilibrium six-factor asset pricing model is statistically and economically feasible of assessing the variation in excess return on the variant FF portfolios.

The contemporaneous asset pricing literature has witnessed the greater success of the factor-based asset pricing models to capture the patterns in expected returns, prominent among is the FF three-factor model and the FF five-factor model. However, the empirical success of the FF five-factor model is marred by its inability to capture the patterns in return on the small stock. Following Fama & French (2016) in US, Kubota & Takehara (2018) in Japan, Foye (2018) in emerging markets, and Roy & Shijin (2018b, 2018c) in emerging and developed economies confirm the failure of the FF five-factor asset pricing model in return predictability. We argue in line with Pantzalis & Park (2009), that the FF five-factor model fails in return predictability because of its inability to capture the risk related to the human capital component (Roy & Shijin, 2018b). Thus, by developing an intertemporal asset pricing framework, which accommodates the human capital component, market portfolio, and the common factors, enables to answer the unresolved puzzle present in the asset pricing literature. The resultant equilibrium six-factor asset pricing model jointly address the two issues, first, the inability of FF five-factor asset pricing model to relate risk associated with human capital component causing its failure, and second, by addressing the joint dynamics of human capital and financial wealth in asset return predictability. Summarily, we argue

that the human capital component is an unaccounted pricing factor of the FF five-factor asset pricing model and hence we claim that the human capital is the sixth factor of FF five-factor model. The findings that the human capital component is a significant component and pricing factor in asset return predictability remains robust to the alternative definitions of human capital. The key result of the study that human capital is an essential component in asset return predictability is in line with the empirical evidence of Eiling (2013). We present the concluding remarks in the successive section.

Concluding remarks

The intriguing puzzle plagued in the financial literature is how to discounting the risk premium and what are the economic forces determine the price of the risk. The joint dynamics of human wealth and financial wealth drives the dynamics governing the aggregate wealth is well established in the asset pricing literature. The risk of an asset is measured by the covariance of asset's return with the return on all invested wealth of an economy. Concurrently, we argue that the measure of all invested wealth of an economy is governed by the joint dynamics of the human capital component and the financial wealth.

The asset pricing literature has witnessed two types of proponents in pricing the risk of an asset, first, measures the risks of an asset risk by the covariance of its return with the return on market portfolio and the common factors. The second proponent estimates the asset's risks by the covariance of asset's return with the return on human wealth and financial wealth. We develop an integrated asset pricing framework consisting of the human capital component, market portfolio, size, value, profitability, and investment as priced factors, which carries the arguments of both the proponents. We test the equilibrium six-factor asset pricing framework on FF portfolios of variant sorts along with the Industry portfolios. The six-factor model performs better than CAPM, FF three-factor model, and FF five-factor asset pricing model across the variant FF portfolios. Further, the empirical results infer that the sensitivity to human capital component priced separately in the presence of market portfolio and the FF pricing factors. The empirical success of the integrated six-factor asset pricing model in return predictability mainly supports our claim that the human capital component and the financial wealth jointly govern the risks of an asset.

Conclusively, our findings contribute to the contemporaneous literature in several ways. First, the present study adds to the existing body of literature on ICAPM approaches (Campbell, 1996, 2000; Palacios, 2015; Pantzalis & Park, 2009). These studies instigated that both the human capital and financial wealth are the equally good components in asset return predictability. Second, to the best of our knowledge there exist no literature or study on multi-factor asset pricing model in an ICAPM framework consisting of the human capital component along with the pricing factors of FF five-factor model in return predictability. Hence, our equilibrium six-factor asset pricing framework is a significant contribution equally in asset return predictability and ultimately to the asset pricing literature. Third, we argue that the failure of FF five-factor asset pricing model in return predictability is because of its inability to relate risk associated with the human capital component. Further, we claim that the human capital is the missing and the sixth factor of FF five-factor asset pricing model. Fourth, our core contribution to the asset pricing literature is the equilibrium six-factor asset pricing model in an ICAPM framework, which provides an integrated

platform that helps to narrow the differences among the two proponents and draw the mutual consensus.

The empirical results and findings equally pose the more significant implications to the decision-making process of the rational investor, institutional managers, portfolio managers, fund managers in formulating the better investment strategies that can help to diversify the aggregate risks.

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Conflict of interest statement

The authors declare no conflict of interest.

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