THE RELATIONSHIP BETWEEN THE FACTORS OF RISK IN ASSET EVALUATION MODELS AND FUTURE ECONOMIC GROWTH: EVIDENCE FROM THREE REGIONAL MARKETS

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ABSTRACT

This study seeks to ascertain whether the risk factors in the asset evaluation models proposed by Fama and French (1993, 2015) contain information that help in forecasting regional economic growth. To this end, based upon samples of Gross Domestic Product for three regions, North America, Asia Pacific and Europe, covering the period between 1991 and 2018, we applied the quantile regression analysis technique. The empirical results suggest that the performance of regional risk factors contains information that helps in forecasting the regional level of economic growth. This furthermore concludes that the regional risk factors help in forecasting the economic growth of countries with developed and large-scale share markets.

Keywords: Fama-French Three and Five Factor Model, Economic Growth, Regional Risk Factors, Investment, Profitability.

JEL Classification: G11, G12, C13

1. INTRODUCTION

The financial economics literature details how analysing the economic growth forecasts may apply to the profitability of share markets. Indeed, various studies, with greater consistency from the 1980s onwards (Fama, 1981, 1990; Fischer & Merton, 1984; Kaul, 1987; Schwert, 1990; Aylward & Glen, 2000; Mauro, 2003; Panopoulou, 2009), have demonstrated how variations in the rate of return of shares perform a relevant role in forecasting economic growth. In practice, this attribute's relevance to share markets as an indicator of economic growth is in keeping with their capacities to provide services for the efficient allocation of resources to the productive sector, encouraging entrepreneurship and technological innovation, qualifying the transaction costs and information at the corporate level (Levine, 1991; Bencivenga, Smith, & Starr, 1996; Greenwood & Smith, 1997).

After formulating their multi-factor asset evaluation models (Fama & French, 1993, 2015) as an alternative to the Capital Asset Pricing Model (CAPM) (Sharpe, 1964; Lintner 1965), Liew and Vassalou (2000) observe how the scale effect and the book-to-market index risk factors for share markets capture information that assists in predicting the economic growth of developed countries. These findings suggest that the asset evaluation models designed to estimate the cost of company capital and the portfolio of investments (e.g., Fama & French, 2004) may serve as indicators of domestic economic development.

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Technological developments focused on the new information and communication technologies have gained a growing role as a factor of innovation in share markets with information having now become globally available stipulating both a new business paradigm that affirms the internationalisation of businesses as well as economic, financial, and monetary harmonisation that have themselves contributed towards accelerating the process of financial market integration across both the regional and global levels (Fratzscher, 2002; Billio & Pelizzon, 2003; Baele, 2005). In effect, this reality drives the formation of risk factors both at the regional and global levels that enable the estimation of the profitability ratios for large-scale domestic share markets (Moer, 2005). Fama and French (2012, 2017) struck out in this direction when, in 2015, they put forward an asset evaluation model made up of five risk factors - market (MKT), size (SMB), book-to-market index (HML), operating profits (RMW), and investment (CMA).

There are few studies analysing the relationship between future economic growth and the regional-level risk factors and their impact on operating profits and investment according to the five-factor asset evaluation model proposed by Fama and French (2015). Hence, the objective of this study consists of applying the quantile regression technique to the 0.05; 0.25; 0.50; 0.75 and 0.95 quantiles to ascertain whether the risk factors for regional share markets in the asset evaluation proposed by Fama and French (1993, 2015) do capture information able to assist in forecasting future economic growth as encapsulated by Gross Domestic Product (GDP hereafter) for the regions of North America, Asia Pacific, and Europe as well as for countries with large-scale, developed share markets.

The motivation for applying the quantile regression analysis technique stems from the nature of asymmetric distribution of the GDP growth rate that may emerge from the different conditional distribution quantiles for risk factor performance. The results returned indicate that the asset evaluation models developed to estimate the cost of capital and investment portfolios may serve as economic indicators as they report information that may assist in forecasting regional and domestic economic growth.

The structure of this study spans five sections. After this introduction, the following section sets out the theoretical framework that details the empirical theoretical developments produced in recent years. Section three describes the methodology, the criteria, and the analytical methods applied in this empirical study. There then follows the analysis and discussion of the results before closing with the conclusion.

2. THEORETICAL FRAMEWORK

The relevance of share markets as an indicator for long-term economic growth stems from the endogenous growth theory formulated by Levine (1991); Bencivenga et al. (1996); and Greenwood and Smith (1997), according to which, share markets act efficiently to reduce liquidity risks, sharing, and diversification of other risks through the dissemination of information about both companies and their management while actively promoting negotiations over their ownership without interrupting their respective productive processes (Levine, 1991). In the context of asset evaluation models, Chen, Roll and Ross (1986) demonstrate that the systematic risk deriving from the development of share markets is not susceptible to representation through means of variables for macroeconomic factors, such as indexes of industrial production, inflation and interest rates, and credit risks. Fama and French (1993) add further factors of risk to CAPM: dimension and the book-to-market index that imitate variables of an unidentified state. Liew and Vassalou (2000) note that the factors of risk proposed by Fama and French (1993) and developments in the share market are interrelated with respect to the future economic growth of ten countries

(Australia, Canada, France, Germany, Italy, Japan, the Netherlands, the United Kingdom, the United States, and Switzerland) over the period from 1978 to 1996. Neves and Leal (2003) observe a positive relationship between the future economic growth of Brazil and the SMB risk factor over the period from 1986 to 2001. Hanhardt and Ansotegui Olcoz (2008) deploy the risk factors of market, size, the book-to-market index, and the positions of share portfolios for five industry types for twelve countries (Austria, Belgium, Finland, France, Greece, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain) in the Eurozone for the period between 1995 and 2003, and the authors concluded that the SMB risk factor contains robust information that assists in predicting economic growth in this region. Liu and Di Iorio (2013) report that the SMB and HML risk factors aid in predicting the economic growth rate of Australia for the period between 1993 and 2010.

Fama and French (2015) present a model with five risk factors spanning the market risks (MKT) that derive from CAPM, size (SMB), the book-to-market index (HML), operating profitability, and CMA investment, as depicted in the equation below (Eq. 1)

$$R_{it} - R_{ft} = \alpha_i + \beta_i(R_{mt} - R_{ft}) + \beta_{is}SMB_t + \beta_{ih}HML_t + \beta_{ir}RMW_t + \beta_{ic}CMA_t + \varepsilon_{it} \quad [1]$$

Where $R_{it} - R_{ft}$, stands for the excess profitability of asset or portfolio i in the period t; R_{mt} represents the market risk; R_{ft} accounts for the free rate risk over the period t; R_{mt}–R_{ft} provides the risk premium that corresponds to the average excess profitability of the market portfolio; SMB_t (Small minus Big) provides for the difference in profitability of diversified share portfolios in small companies in contrast with large companies; HML_t (High minus Low) conveys the difference between the profitability rates of diversified share portfolios in high and low book-to-market ratio, $RMW_{t,}$ (Robust Minus Weak) is the operating profit factor that stems from the difference between the profitability rates of diversified share portfolios in high operating profit companies against those turning in low operating profits; and the CMA_t (Conservative Minus Aggressive) investment factor results from the difference between the profitability of diversified share portfolios in companies with low and high levels of investment, with ε_{it} as the residual.

3. METHODOLOGY

The objective of this research is to analyse the risk factors in the three- and five-factor asset evaluation models proposed by Fama and French (1993, 2015) for the regions of North America, Asia Pacific, and Europe to ascertain whether they assist in predicting the future economic growth of these regions as well as countries with developed and large-scale share markets. To this end, we apply the quantile regression technique to the diverse, conditioned distribution quantiles for GDP growth, represented by the intervals, 0.05, 0.25, 0.50, 0.75, and 0.95, in which the quantiles 0.05 and 0.25 represent low growth rates, 0.50 accounts for moderate growth, and quantiles equal to or above 0.75 depict high growth. For the purposes of comparing the meaning and the magnitude of the coefficients, this also applies the ordinary least squares (OLS) regression method.

The regression quantiles (RQ) put forward by Koenker and Bassett (1978) feature the minimisation of the weighted sum for the absolute residuals, and the model estimates the parameters for the regression across different quantiles (between 0 and 1) of the conditional dependent variable for the vector of explanatory variables through the median. In turn, the median describes the best measurement of the central trend given that this is not subject to the impact of extreme values, unlike the average (Fávero & Belfiore, 2017). Hence, in accordance with Koenker and Bassett (1978) and Buchinsky (1998), quantile regression (i)

represents a robust regression technique with its parameter estimators not influenced by extreme data; (ii) does not follow the assumption of normality among the residuals; and (iii) provides more complete information that enables the explanation and prediction of the behaviour of the dependent variable given the variations taking place in the independent variables.

In accordance with Fávero and Belfiore (2017), the general quantile regression model is as follows:

$$Y_i = a + b_{\emptyset 1}X_{1i} + b_{\emptyset 2}X_{2i} + \cdots + b_{\emptyset k}X_{ki} + u_{\emptyset i} = X_i' b_{\emptyset} + u_{\emptyset i} \quad [2]$$

with:

$$Perc_{\emptyset}(Y_i|X_i) = X_i' b_{\emptyset} \quad [3]$$

Where $Perc_{\emptyset}(Y_i|X_i)$ represents the percentile Ø ($0 < Ø < 1$) of the dependent variable Y, conditional on the vector of the independent variables X'.

Reflecting the vector of the explanatory variable in the equations (Eq. 2 and 3) by F (Factor), we thus define the quantile regression model applied in this study as the following:

$$GDP_i = F_i' \beta_{\emptyset} + u_{\emptyset i}, \quad Quant_{\emptyset}(GDP_i|XF_i) = F_i' \beta_{\emptyset} \quad [4]$$

Where $Quant_{\emptyset}(GDP_i|F_i)$ represents the quantile Ø ($0 < Ø < 1$) of the dependent variable GDP, conditional on the vector of the independent variable F'.

For this empirical study, the analysis of the relationship between future economic growth and the regional factors of risk incorporates the application of eight regression models, with six univariate regression models to verify whether each risk factor individually captures information on economic growth and two multivariate regression models with three and five risk factors, respectively. The first six models depicted in the equation (Eq. 5) estimate the relationship between the regional GDP growth rate and each of the six factors of regional risk, MKT, SMB, HML, RMW, and CMA. Liew and Vassalou (2000) observe how the MKT, SMB, and HML risk factors independently help in predicting the economic growth of developed countries. This empirical study extends the analysis to the RMW and CMA regional risk factors. Equation 5 is given by:

$$GDP_t = \alpha + \beta Fator_{t-1} + \varepsilon_t \quad [5]$$

Where GDP_t denotes the GDP growth rate for the period t calculated logarithmically; $Factor_{t-1}$, accounts for the profitability of the regional factors of risk MKT, SMB, HML, RMW, and CMA in the preceding period; and ε_t is the residual of the regression equation.

The MKT risk factor derives from the difference in the weighted average of the listed capitalisation of each share and the monthly America treasury bond rate. The SMB risk factor corresponds to the stock market capitalisation of each company and results from the multiplication of each share price with the number of shares in circulation. The HML risk factor results from the division of the accountancy value of each company and its listed share value. The RMW risk factor stems from dividing the pre-tax result for the period t by the value of net assets of the company for the same period. The calculation of the CMA risk factor, in turn, divides the difference in the total value of the assets over the period t-1 and t-2 by the total asset value for period t-2.

The calculation of the SMB, HML, RMW, and CMA risk factors dates to the end of June of each year based on six weighted portfolios formed by the intersection (2x3) of two SMB groups and three HML, RMW, and CMA groups. The separation of the two SMB group takes place at the 90 and 10 percentile points. The 90 percentile depicts the group of large-scale shares, and the 10 percentile represents the share group classified as small scale. The three groups for each of the HML, RMW, and CMA risk factors divide at the 30 and 70 percentile points. Hence, in accordance with the risk factor, the group of shares returning values below the 30 percentile point rank as Low – L, Weak – W, and Conservative – C; while the percentiles between 30 and 70 classify as Neutral – N and those above the 70 percentile corresponding to High – H, Robust – R, and Aggressive – A. Therefore, these classifications enable the establishing of six portfolios, 2x3 (Small, S; Big, B; Low, L; Neutral, N; and High, H) for each group, SMB and HML, SMB and RMW, and CMA, through the intersection of the two asset groups (Small – S and Big – B) formed out of the size of the company and the three share groups (Low, L; Neutral, N and High, H), classified according to book-to-market, operating profit, and investment.

Hence, for the three-factor model, SMB (hereafter designated as SMB3F) emerges from the difference between the weighted average and the profitability of the three small-scale share portfolios and the three large-scale share portfolios as set out in the following equation (Eq. 6).

$$SMB = 1/3(SL + SN + SH) - 1/3(BL + BN + BH) \quad [6]$$

In turn, the five-factor SMB model stems from the average differences in profitability of the nine small-scale share portfolios and the nine large-scale share portfolios in terms of SMB book-to-market, SMB operating profit (OP), and SMB investment (INV), as conveyed by the following equations (Eq. 7, 8, 9, 10).

$$SMB_{B/M} = 1/3(SL + SN + SH) - 1/3(BL + BN + BH) \quad [7]$$

$$SMB_{OP} = 1/3(SW + SN + SR) - 1/3(BW + BN + BR) \quad [8]$$

$$SMB_{INV} = 1/3(SC + SN + SA) - 1/3(BC + BN + BA) \quad [9]$$

$$SMB = 1/3(SMB_{B/M} + SMB_{OP} + SMB_{INV}) \quad [10]$$

The HML, RMW, and CMA risk factors arise out of the difference between the weighted average of the profitability of the two high (H) and low (L) share portfolios across the factors of book- to-market, robust (R) and weak (W) operating profit, and conservative (C) and aggressive (A) investment, as portrayed by the following equations (Eq. 11, 12, 13).

$$HML = 1/2(SH + BH) - 1/2(SL + BL) \quad [11]$$

$$RMW = 1/2(SR + BR) - 1/2(SW + BL) \quad [12]$$

$$CMA = 1/2(SA + BA) - 1/2(SC + BC) \quad [13]$$

The estimating of models seven and eight formed by a set of three and five independent variables—established by the risk factors in the asset evaluation models incorporating three and five risk factors (Fama and French, 1993; 2015), as represented by the equations (Eq. 14, 15)—seeks to analyse the relationship between the regional GDP growth rate and that of countries with developed and large-scale share markets.

$$GDP_t = \alpha + \beta_1 MKT_{t-1} + \beta_2 SMB_{t-1} + \beta_3 HML_{t-1} + \varepsilon_t \quad [14]$$

$$GDP_t = \alpha + \beta_1 MKT_{t-1} + \beta_2 SMB_{t-1} + \beta_3 HML_{t-1} + \beta_4 RMW_{t-1} + \beta_5 CMA_{t-1} + \varepsilon_t \quad [15]$$

3.1 Description of the Data

3.1.1 Sample

For this empirical study, we applied the historical annual series of data on GDP, calculated in American dollars, for the period between January 1991 to 2018 and the profitability rates of the risk factors in the asset evaluation models for the regions of North America (Canada and the United States), Asia Pacific (Australia, Hong Kong, New Zealand, and Singapore) and Europe (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom). We sourced the profitability and GDP data from the databases of Kenneth French and the World Bank, respectively.

The calculation of GDP for each of the three regions adopted the classification provided by Fama and French (2012, 2017) for establishing the regional risk factors based on the profitability of the developed stock markets of North America, Asia Pacific, and Europe. Correspondingly, the GDP for the North America region incorporates the sum of the GDP of Canada and the United States; while the Asia Pacific region features the GDP of Australia, Hong Kong, New Zealand, and Singapore; and in the case of the GDP for the Europe region, it consists of seventeen European Union member states: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom. Analysis of the relationship between the regional risk factors and the GDP of countries with developed and large-scale stock markets includes a total of five countries - Canada, France, Germany, Singapore, the United States of America - plus the Administrative Region of Hong Kong, a selection of two for each region.

4. RESULTS

4.1 Descriptive Statistics and the Adherence Tests

Table 1 presents a summary of the descriptive statistics and the adherence tests for the normality (Jaque-Bera, JB) and stationarity (Augmented Dickey-Fuller, ADF) of the profitability of the risk factors for regional stock markets and regional GDP growth rates and for countries with developed and large-scale share markets over the period from January 1991 to December 2018. We started out calculating the ADF with a maximum lag of 8, the Akaike (1974) information criteria (AIC) and t statistical method for ascertaining the absence of a unit root.

This details how the risk factors returned by the regional Asia Pacific model, MKT (11.92%) and SMB3F (-1.03%), respectively, report the highest and lowest average risk premiums. The median varies between -0.3.45% (SMB3F, Asia Pacific) and 11.86% (MKT, North America). The total range of the set of observations of profitability varied from 28.38% (RMW, Europe) and 133.89% (MKT, Asia Pacific). The standard deviation in the risk premiums varied from 0.07 (RMW, Europe) to 0.30 (MKT, Asia Pacific). The asymmetry and Kurtosis measurements emerge as heterogeneous. The Asia Pacific regional market returned the strongest trend for positive asymmetry, with the North American regional market providing the best trend in the distribution of the frequency of leptokurtic type profitability. The coefficients estimated for the normality test indicate that the regional risk factors for the North America and Europe regions follow a normal distribution pattern, with the exception being the CMA (8.67) factor associated with North America.

Table 1. Descriptive statistics and the adherence test for the annual GDP growth rates and the profitability of the regional risk factors in the three-and five-factor asset evaluation models

Region	Variable	$\bar{X}$	Md	Min	Max	S	A	K	JB	ADF
		%	%	%	%					
North America										
	MKT	9.53	11.86	-39.54	32.47	0.18	-0.92	0.63	4.27	-1.00***
	SMB3F	0.95	-0.63	-25.62	22.61	0.10	-0.13	0.43	0.27	-4.61***
	SMB	2.03	2.55	-26.87	22.24	0.10	-0.42	0.66	1.28	-0.74***
	HML	3.10	1.91	-33.41	50.03	0.17	0.35	1.04	1.76	-1.12***
	RMW	4.14	7.54	-18.35	25.50	0.10	-0.40	0.37	0.88	-1.21***
	CMA	3.14	3.98	-20.04	46.56	0.14	0.84	2.20	8.67**	-1.08***
	GDP	2.53	2.65	-2.61	4.68	0.01	-1.48	3.46	23.30***	-0.52**
Canada	GDP	2.41	2.63	-2.99	5.05	0.02	-1.15	3.17	17.27***	-0.77***
USA	GDP	2.54	2.72	-2.57	4.64	0.02	-1.43	3.04	11.98***	-0.51*
Asia Pacific										
	MKT	11.92	9.58	-52.97	80.92	0.30	0.38	0.20	0.68	-3.04**
	SMB3F	-1.03	-3.45	-18.30	31.99	0.12	1.09	0.82	6.11**	-1.69***
	SMB	0.64	-1.44	-15.27	29.48	0.11	1.01	0.40	4.78*	-5.52***
	HML	8.08	6.47	-7.90	26.65	0.09	0.07	-0.54	0.35	-0.92***
	RMW	2.15	2.02	-20.11	20.28	0.09	0.18	0.14	0.17	-0.83***
	CMA	3.08	4.83	-45.64	23.67	0.13	-2.09	5.48	53.55 ***	-1.38***
	GDP	3.45	3.49	0.94	5.09	0.01	-0.37	-0.65	1.10	-0.99***
Hong Kong										
	GDP	3.58	3.05	-6.06	8.34	0.03	-1.08	1.77	8.78**	-0.91***
Singapore	GDP	5.55	5.57	-2.22	13.56	0.04	-0.07	-0.24	0.09	-0.92***
Europe										
	MKT	7.74	9.69	-47.52	41.66	0.20	-0.65	0.28	1.99	-4.00***
	SMB3F	1.23	3.44	-15.51	15.67	0.09	-0.22	-1.21	1.86	-0.89***
	SMB	1.99	4.85	-15.02	16.73	0.09	-0.29	-1.16	1.89	-0.80***
	HML	4.18	2.28	-23.55	27.54	0.13	0.00	-0.48	0.25	-0.76**
	RMW	5.00	3.74	-10.16	18.22	0.07	0.00	-0.33	0.12	-1.11**
	CMA	1.94	-0.36	-20.42	18.89	0.09	-0.01	-0.19	0.04	-0.81**
	GDP	1.65	1.94	-4.37	3.73	0.02	-2.15	5.96	60.79***	-0.75***
Germany	GDP	1.40	1.72	-5.78	4.00	0.02	-2.02	5.92	57.70***	-1.52***
France	GDP	1.57	1.71	-2.92	3.85	0.01	-1.19	2.64	14.25***	-0.72**

Notes: $\bar{X}$, average; Md, median; Min, minimum; Max, maximum; S, standard deviation; A, asymmetry; K, Kurtosis; JB, Jaque-Bera test; ADF, Augmented Dickey-Fuller test.

Source: Own Elaboration

This details how the risk factors returned by the regional Asia Pacific model, MKT (11.92%) and SMB3F (-1.03%), respectively, report the highest and lowest average risk premiums. The median varies between -0.3.45% (SMB3F, Asia Pacific) and 11.86% (MKT, North America). The total range of the set of observations of profitability varied from 28.38% (RMW, Europe) to 133.89% (MKT, Asia Pacific). The standard deviation in the risk premiums varied from 0.07 (RMW, Europe) to 0.30 (MKT, Asia Pacific). The asymmetry and Kurtosis measurements emerge as heterogeneous. The Asia Pacific regional market returned the strongest trend for positive asymmetry, with the North American regional market providing the best trend in the distribution of the frequency of leptokurtic type profitability. The coefficients estimated for the normality test indicate that the regional risk factors for the North America and Europe regions follow a normal distribution pattern, with the exception being the CMA (8.67) factor associated with North America.

The asymmetric negative association of the GDP growth rates receives confirmation from the asymmetry coefficients. The ADF test results set out in Table 1 report the absence of any unit root with a statistical significance of between 1% and 10%.

4.2 Empirical Results

4.2.1 Evaluating the relationship between the risk factors and economic growth –the univariate model

Table 2 details the estimates for the six univariate models resulting from equation (Eq. 5) according to the regression quantile (RQ) method applied to the quantiles 0.05, 0.25, 0.50, 0.75, and 0.95 and the ordinary least squares (OLS) method for the purposes of comparison. For the models estimated by the OLS method that report self-correlation and heteroscedasticity in their residuals, we applied the Newey and West (1987) and White (1980) robust estimators in order to correct the standard error.

The results presented by this empirical study, through recourse to the Gretl econometric software, omit the estimates in the diagnostic test for the presence of multicollinearity, which did not register any presence, and omit the adjustment coefficients (R^2); nevertheless, these results are available on request.

Table 2 details how the MKT risk factor, as expected, returned a positive and statistically significant relationship with the future regional economic growth rates. This finding further strengthens the centrality of the MKT risk factor as already observed by Levy and Roll (2010). The SMB3F, SMB, and HML risk factors return positive coefficients for the Asia Pacific and Europe regions. The SMB3F and SMB risk factors attained statistical significance at 5% in the case of the Asia Pacific market. These results thus align with those of Liew and Vassalou (2000), Neves and Leal (2013), and de Liu and Di Iorio (2013).

The magnitude of the positive coefficients reflects most clearly in the estimates produced by quantile regression. In effect, this demonstrates how the lowest quantiles (0.05, 0.25) for the conditional distribution of the GDP growth rates generate the highest coefficients. With the exception of CMA, all of the other risk factors return at least a positive coefficient, thus countering the estimates returned by the OLS method. The MKT risk factor displayed a positive and stable relationship with the regional economic growth rates across all of the quantiles subject to analysis. All of the quantiles obtained statistical significance at 5% apart from the 0.95 quantile for the Asia Pacific market. The confirmation of the asymmetry in the economic growth rates resulting from the MKT effect is verifiable in the estimated coefficients. In the case of North America, the MKT risk factor produced a positive effect in the order of 3.3% (quantile 0.25) and 7% (quantile 0.05), against a constant value of 5.5% estimated by the OLS method. This observation extends to the economic growth rates for the Asia Pacific and Europe regions where the MKT risk factor for each region returns a positive effect in the order of 1.7% (quantile 0.75) to 2.3% (quantile 0.50) and 1.9% (quantile 0.50) to 7.6% (quantile 0.05), respectively, against an average value of 1.9% (Asia Pacific) and 5% (Europe), and statistically significant at 5% in the OLS estimates.

Table 2. OLS and RQ results for the model GDP = $\alpha + \beta_1 Fator_{t-1} + \varepsilon_t$, for each of the MKT, SMB3F, SMB, HML, RMW and CMA risk factors

Region	Model	OLS	RQ	RQ	RQ	RQ	RQ
			0.05	0.25	0.5	0.75	0.95
North America							
	MKT	0.055***	0.070***	0.033***	0.043***	0.049***	0.041***
		(0.017)	(0.013)	(0.009)	(0.015)	(0.016)	(0.005)
	SMB3F	-0.002	0.073**	-0.002	0.004	-0.025	-0.014
		(0.030)	(0.033)	(0.037)	(0.013)	(0.048)	(0.010)
	SMB	-0.009	0.072***	-0.002	-0.005	-0.036	-0.026
		(0.031)	(0.005)	(0.027)	(0.012)	(0.039)	(0.011)
	HML	-0.009	0.017***	-0.020**	-0.019	-0.020	-0.011**
		(0.017)	(0.004)	(0.009)	(0.012)	(0.020)	(0.006)
	RMW	-0.042**	-0.142***	-0.043	-0.046**	-0.034	0.007
		(0.017)	(0.009)	(0.034)	(0.018)	(0.027)	(0.006)
	CMA	-0.024**	-0.144***	-0.025*	-0.032**	-0.037	-0.039
		(0.012)	(0.009)	(0.014)	(0.012)	(0.026)	(0.024)
Asia Pacific							
	MKT	0.019***	0.019***	0.020***	0.023**	0.017***	0.005
		(0.006)	(0.006)	(0.005)	(0.009)	(0.005)	(0.007)
	SMB3F	0.040**	0.068**	0.043**	0.057*	0.022	0.011
		(0.018)	(0.026)	(0.016)	(0.031)	(0.015)	(0.006)
	SMB	0.041**	0.078**	0.049**	0.056	0.034	0.010
		(0.015)	(0.021)	(0.018)	(0.035)	(0.021)	(0.007)
	HML	0.007	-0.028	-0.002	0.011	0.029	0.023
		(0.025)	(0.020)	(0.034)	(0.044)	(0.025)	(0.026)
	RMW	-0.025	-0.091***	-0.004	-0.033*	-0.030*	0.008
		(0.023)	(0.015)	(0.032)	(0.017)	(0.017)	(0.016)
	CMA	-0.028	-0.049***	-0.026***	-0.015	-0.018	-0.020
		(0.016)	(0.004)	(0.008)	(0.025)	(0.020)	(0.013)
Europe							
	MKT	0.050**	0.076***	0.049**	0.019**	0.030**	0.038***
		(0.018)	(0.006)	(0.020)	(0.011)	(0.011)	(0.013)
	SMB3F	0.055	0.308***	0.087***	0.026	-0.019	0.025*
		(0.036)	(0.035)	(0.015)	(0.023)	(0.019)	(0.013)
	SMB	0.053	0.302***	0.084***	0.027	-0.018	0.029*
		(0.036)	(0.051)	(0.009)	(0.028)	(0.029)	(0.016)
	HML	0.018	0.050***	0.034	0.009	-0.009	-0.021**
		(0.024)	(0.007)	(0.037)	(0.017)	(0.016)	(0.009)
	RMW	-0.041	-0.028	-0.070**	-0.052**	-0.030	0.070***
		(0.046)	(0.062)	(0.031)	(0.027)	(0.039)	(0.005)
	CMA	-0.055*	-0.255***	-0.057*	-0.025	-0.042***	-0.029***
		(0.032)	(0.046)	(0.033)	(0.026)	(0.009)	(0.005)

Notes: OLS, ordinary least squared; RQ, regression quantile; Standard error in parentheses; ***, **, *, statistically significant at 1%, 5% and 10%.

Source: Own Elaboration

The SMB3F, SMB, HML, and RMW risk factors act in different ways across each of the three regional markets under analysis. As Table 2 sets out, in the case of regional GDP for North America, the coefficients estimated for the risk factors of SMB3F, SMB, HML, and RMW report a positive effect of 1.7% (HML), 7.3% (SMB3F), 7.2% (SMB) (quantile 0.05), and 7% (RMW) (quantile 0.95) in contrast with the negative estimates obtained by OLS.

In relationship to the Asia Pacific region, the SMB3F and SMB risk factors generate positive coefficients across every quantile under analysis with statistical significance at 5% for the lower and median quantiles (6.8%, 4.3%, and 5.7%, SMB3F; 7.8% and 4.9%, SMB),

thereby higher than the coefficients estimated by the OLS method (4%, SMB3F and 4.1%, SMB). The HML risk factor provided positive coefficients from the 0.50 quantile upwards while not obtaining statistical significance, with the RMW risk factor presenting a positive coefficient in the 0.95 quantile without achieving statistical significance alongside the value returned by the OLS method.

In the case of the Europe region, the SMB3F and SMB risk factors reported positive and significant coefficients between 5% and 10% between the first and third quantiles. The magnitude of the coefficients was in the order of 2.5% and 2.9% (quantile 0.95, SMB3F and SMB) rising to 30.8% and 30.2% (quantile 0.05, SMB3F & SMB), against the average values of 5.5% and 5.3% without achieving statistical significance estimated by OLS. The HML risk factor returned a positive relationship (5%), statistically significant at 5%, in the 0.05 quantile, contrary to the average value returned by calculating OLS. In the case of the RMW risk factor, there was a positive and statistically significant relationship in the 0.95 quantile with a 7% effect, different to the negative average value estimated by the OLS method. The negative relationship of the CMA risk factor, in keeping with the results for the North America and Asia Pacific regions, received confirmation through the regression quantile method.

4.2.2 Evaluating the relationship between the three-risk factor model and economic growth

Table 3 presents the estimates obtained by the OLS and regression quantile methods that adopt as their independent variables the MKT, SMB, and HML risk factors proposed by Fama and French (1993) as set out in equation (Eq. 14).

For the three- and five-factor models, the analysis of the relationship between GDP and the regional risk factors extends to the six countries with developed stock markets. Moerman (2005) concluded that the regional risk factors turn in a better performance in large-scale share markets in terms of their calculating expected profitability when compared with the domestic risk factors.

The results detailed in Table 3 align with the observation of Fama and French (2017) as regards how the regional risk factors operate differently in each of the markets.

In relationship to the regional GDP of North America, as well as for the GDP of Canada and the United States, the positive performance and statistical significance at 5% of the MKT and HML risk factors took place in two of the five quantiles. With the exception of the MKT risk factor, the average values estimated by OLS do not obtain significance. The MKT performance in terms of regional and domestic GDP stood at 1.4% (quantile 0.95, North America) and 9% (quantile 25, North America and the United States). The positive effect of the SMB risk factor on the GDP of Canada emerged in two quantiles with a range of coefficients ranging from 2.6% (quantile 0.05) to 3.9% (quantile 0.50). In the case of the HML factor of risk, the positive effect on regional and domestic GDP came in between 2.4 (quantile 0.25, United States) and 6.1% (quantile 0.05, Canada).

Table 3. Multiple regression estimates for the model GDP = $\alpha + \beta_1 MKT_{t-1} + \beta_2 SMB_{t-1} + \beta_3 HML_{t-1} + \varepsilon_t$

Region	Model	OLS	RQ	RQ	RQ	RQ	RQ
			0.05	**0.25**	**0.5**	**0.75**	**0.95**
North America							
	MKT	0.063***	0.071***	0.087***	0.042***	0.043***	0.043***
		(0.020)	(0.006)	(0.005)	(0.008)	(0.012)	(0.012)
	SMB	-0.023	-0.010	-0.037***	0.000	-0.030	-0.014
		(0.019)	(0.009)	(0.008)	(0.013	(0.019)	(0.020)
	HML	0.014	0.037***	0.027***	0.011	-0.009	0.004
		(0.019)	(0.006)	(0.005)	(0.008)	(0.012)	(0.013)
Canada							
	MKT	0.057**	0.070***	0.049***	0.022***	0.037***	0.060***
		(0.021)	(0.009)	(0.013)	(0.006)	(0.006)	(0.010)
	SMB3F	-0.008	0.026*	0.006	0.039***	-0.019*	-0.002
		(0.034)	(0.014)	(0.021)	(0.009)	(0.010)	(0.016)
	HML	0.033	0.061***	0.025*	0.019***	-0.008	-0.001
		(0.021)	(0.009)	(0.014)	(0.006)	(0.006)	(0.011)
USA							
	MKT	0.063***	0.070***	0.088***	0.048***	0.047**	0.039***
		(0.020)	(0.005)	(0.007)	(0.012)	(0.023)	(0.009)
	SMB	-0.024	0.003	-0.051***	-0.005	-0.029	-0.015
		(0.019)	(0.008)	(0.012)	(0.019)	(0.037)	(0.015)
	HML	0.013	0.036***	0.024***	0.011	-0.007	0.004
		(0.019)	(0.005)	(0.008)	(0.012)	(0.024)	(0.009)
Asia Pacific							
	MKT	0.016*	-0.009	0.020***	0.013	0.012	0.022***
		(0.008)	(0.006)	(0.003)	(0.008)	(0.009)	(0.008)
	SMB	0.014	0.122***	0.024***	0.038*	0.022	-0.042*
		(0.023)	(0.015)	(0.008)	(0.021)	(0.024)	(0.022)
	HML	-0.002	0.083***	0.010	0.040*	-0.008	0.021
		(0.025)	(0.016)	(0.009)	(0.024)	(0.027)	(0.024)
Hong Kong							
	MKT	0.072***	0.031	0.045***	0.095***	0.081***	0.120***
		(0.019)	(0.032)	(0.004)	(0.011)	(0.015)	(0.001)
	SMB	0.014	0.287***	0.029***	0.006	0.015	-0.106***
		(0.050)	(0.082)	(0.010)	(0.029)	0.039	(0.001)
	HML	0.020	0.224**	0.005	0.014	-0.003	-0.015***
		(0.055)	(0.091)	(0.011)	(0.032)	(0.043)	(0.001)
Singapore							
	MKT	0.081***	0.016	0.086***	0.087***	0.081***	0.056***
		(0.023)	(0.011)	(0.026)	(0.026)	(0.002)	(0.014)
	SMB	0.041	0.232***	0.077	0.025	-0.004	0.001
		(0.060)	(0.028)	(0.068)	(0.068)	(0.004)	(0.036)
	HML	-0.056	0.209***	-0.002	-0.074	-0.098***	-0.092**
		(0.066)	(0.030)	(0.076)	(0.075)	(0.005)	(0.040)

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Table 3 (continue)

Region	Model	OLS	RQ	RQ	RQ	RQ	RQ
			0.05	**0.25**	**0.5**	**0.75**	**0.95**
Europe							
	MKT	0.047**	0.071***	0.025***	0.032**	0.021	0.024***
		(0.018)	(0.003)	(0.005)	(0.015)	(0.015)	(0.005)
	SMB	0.016	-0.107***	0.040***	0.000	-0.017	0.011
		(0.020)	(0.007)	(0.012)	(0.033)	(0.033)	(0.009)
	HML	0.014	0.107***	0.025***	0.016	0.004	-0.012*
		(0.014)	(0.005)	(0.008)	(0.022)	(0.022)	(0.007)
Germany							
	MKT	0.057**	0.103***	0.028	0.046***	0.028***	0.021***
		(0.023)	(0.001)	(0.018)	(0.009)	(0.005)	(0.005)
	SMB	0.031	-0.085***	0.045	0.045**	0.036***	0.081***
		(0.019)	(0.002)	(0.039)	(0.019)	(0.010)	(0.012)
	HML	-0.012***	-0.020**	-0.054	-0.009	0.003	0.019**
		(0.019)	(0.001)	(0.027)	(0.013)	(0.007)	(0.008)
France							
	MKT	0.041***	0.052***	0.031***	0.027**	0.025**	0.022***
		(0.013)	0.012	0.005	0.012	0.004	0.003
	SMB	0.005	-0.031	0.033***	0.000	-0.034***	-0.037***
		(0.023)	(0.027)	(0.012)	(0.026)	(0.009)	(0.006)
	HML	0.010	0.029	0.037***	0.016	-0.005	-0.039***
		(0.012)	(0.018)	(0.008)	(0.018)	(0.006)	(0.004)

Notes: USA, United States of America; OLS, ordinary least squared; RQ, regression quantile; Standard error in parentheses; ***, **, *, statistically significant at 1% and 5%.

Source: Own Elaboration

Liew and Vassalou (2000) encounter a positive relationship between the GDP of the United States and the three-factor local risk model for the periods between 1957 and 1998 and between 1978 and 1996. In the case of Canada, these authors observe a positive relationship in the MKT and SMB risk factors over the period from 1978 to 1996.

In terms of the GDP of the Asia Pacific region, as well as the domestic figures for Hong Kong and Singapore, the MKT, SMB, and HML risk factors report positive and statistically significant performances at 5% across the four quantiles. With the exception of the MKT risk factor, the OLS-measured values do not obtain statistical significance. In the case of the MKT risk factor, the variation in the coefficients ranged from 2% (quantile 0.25, Asia Pacific) to 12% (quantile 0.95, Hong Kong). The participation of the SMB risk factor varied between 2.9% (quantile 0.25, Asia Pacific) and 28.7% (quantile 0.05). The HML risk factor generated a positive effect rising from 4% (quantile 0.50, Asia Pacific) to 22.4% (quantile 0.05, Hong Kong).

In relation to the regional GDP figures for Europe as well as the national economies of Germany and France, the three regional risk factors are statistically significant at 5% and have positive performances between one and five quantiles. For the MKT factor, the variation in the coefficients ranged from 2.1% (quantile 0.95; Germany) to 10.3% (quantile 0.05, Germany). The performance of the SMB risk factor rose from 3.3% (quantile 0.25, France) to 8.1% (quantile 0.95). In turn, the HML risk factor generated a positive effect, ranging from 1.9% (quantile 0.9, Germany) to 10.7% (quantile 0.05, Europe).

Liew and Vassalou (2000) return a positive relationship between the MKT and SMB risk factors and German GDP for the period from 1987 to 1996. Following analysis of France, the authors identified positive coefficients for the SMB and HML risk factors for the period between 1983 and 1996. Hanhardt and Ansotegui Olcoz (2008) encounter a positive relationship between the SMB factor and economic growth in the Eurozone.

4.2.3 Evaluating the relationship between the five-risk factor model and economic growth

Table 4 provides the estimates returned by the OLS method and the regression quantile with five independent variables incorporated into the five-risk factor asset evaluation model demonstrated in equation (Eq. 15).

Liew and Vassalou (2000) argue that the presence of a positive relationship between the SMB and HML risk factors conveys how a period of economic growth is possible when small-scale shares and high B/M indexes achieve better levels of performance than large-scale shares and low B/M indexes, which motivates investors to hold shares that generate high profitability rates, and, when observing an eventual change in the economic cycle, this analysis extends to the RMW and CMA risk factors.

The estimates returned by the OLS method indicate how the regional MKT and HML risk factors maintain a positive relationship with the GDP for the North America region as well as for the United States. Analysis of the results for Canada demonstrates how the MKT, HML, and CMA risk factors return positive coefficients.

The results deriving from the Asia Pacific region, as well as those for Singapore at the national level, report the existence of positive coefficients for the MKT, SMB, RMW, and CMA risk factors, while only the MKT risk factor obtains statistical significance at 5%. For Hong Kong GDP, the positive relationship only arises with the MKT, SMB, and CMA risk factors, with the MKT risk factor attaining statistical significance at the 1% level.

For the region of Europe and France's national level, the MKT, SMB, and HML risk factors produce positive coefficients, with the HML factor obtaining statistical significance at 1%. The results for Germany were different, however. The MKT, SMB, HML, and RMW risk factors generate positive relationships even while statistical significance at 10% was the case only for the HML risk factor.

The results returned by the regression quantile method provide a complete vision on the conditional GDP movements in accordance with the five risk factors. In relation to the regional GDP of North America, the MKT and HML risk factors return statistically significant at 5% and positive effects in the extreme quantiles. The centrality of the MKT risk factor emerges both in terms of its statistical significance at 5% and also in the magnitude of coefficients that range from between 1.4% (quantile 0.95) to 9% (quantile 0.25). In terms of the HML risk factor, the variation in the coefficients ranged from 3.4% (quantile 0.95) to 6.4% (quantile 0.05). The RMW risk factor presented positive effects, obtaining a magnitude of 3.1% (quantile 0.25), against the negative average value (-0.9%) returned by the OLS method. The absence of any positive effect from the SMB and CMA risk factors according to the OLS method received confirmation across every quantile.

Table 4. Multiple regression estimates for the model GDP = $\alpha + \beta_1 MKT_{t-1} + \beta_2 SMB_{t-1} + \beta_3 HML_{t-1} + \beta_4 RMW_{t-1} + \beta_5 CMA_{t-1} + \varepsilon_t$

Region	Model	OLS	RQ	RQ	RQ	RQ	RQ
			0.05	**0.25**	**0.50**	**0.75**	**0.95**
North America							
	MKT	0.058***	0.068***	0.090***	0.055**	0.019	0.014**
		(0.021)	(0.015)	(0.027)	(0.026)	(0.035)	(0.006)
	SMB	-0.027	-0.004	-0.026	-0.011	-0.044	-0.041***
		(0.023)	(0.023)	(0.041)	(0.039)	(0.052)	(0.010)
	HML	0.030	0.064**	0.039	0.049	0.026	0.034**
		(0.028)	(0.031)	(0.055)	(0.053)	(0.070)	(0.013)
	RMW	-0.009	-0.004	0.031	-0.014	-0.035	-0.022**
		(0.023)	(0.026)	(0.046)	(0.045)	(0.059)	(0.011)
	CMA	-0.014	-0.031	-0.024	-0.044	-0.031	-0.043**
		(0.027)	(0.038)	(0.068)	(0.065)	(0.086)	(0.016)
Canada							
	MKT	0.051**	0.063***	0.074***	0.033*	0.006	-0.033***
		(0.020)	(0.002)	(0.000)	(0.017)	(0.036)	(0.010)
	SMB	-0.020	0.001	-0.032***	0.023	-0.039	-0.058***
		(0.030)	(0.003)	(0.000)	(0.026)	(0.053)	(0.015)
	HML	0.029	0.122***	0.090***	0.036	0.038	0.034*
		0.041	(0.003)	(0.000)	(0.035)	(0.072)	(0.020)
	RMW	-0.032	-0.016***	-0.025***	0.018	-0.077	-0.053***
		0.035	(0.004)	(0.000)	(0.029)	(0.060)	(0.017)
	CMA	0.004	-0.071***	-0.033***	-0.008	-0.031	-0.062**
		(0.050)	(0.006)	(0.000)	(0.043)	(0.088)	(0.024)
USA							
	MKT	0.059***	0.067***	0.090***	0.052**	0.028	0.017
		(0.020)	(0.017)	(0.021)	(0.029)	(0.027)	(0.011)
	SMB	-0.027	0.008	-0.044	-0.010	-0.039	-0.036**
		(0.023)	(0.025)	(0.031)	(0.043)	(0.041)	(0.016)
	HML	0.030	0.055	0.038	0.031	0.024	0.030
		(0.027)	(0.033)	(0.042)	(0.059)	(0.055)	(0.022)
	RMW	-0.007	-0.004	0.025	-0.008	-0.027	-0.015
		(0.023)	(0.028)	(0.035)	(0.049)	(0.046)	(0.018)
	CMA	-0.016	-0.023	-0.020	-0.030	-0.031	-0.036
		(0.027)	(0.041)	(0.051)	(0.071)	(0.067)	(0.027)
Asia Pacific							
	MKT	0.033**	0.009***	0.026***	0.054**	0.043***	0.021**
		(0.015)	(0.003)	(0.000)	(0.022)	(0.002)	(0.009)
	SMB	0.011	0.097***	0.045***	0.008	-0.016***	-0.056***
		(0.023)	(0.004)	(0.000)	(0.034)	(0.003)	(0.015)
	HML	-0.016	-0.005	0.013***	-0.041	-0.014***	0.038**
		(0.026)	(0.005)	(0.000)	(0.038)	(0.003)	(0.016)
	RMW	0.029	0.047***	0.041***	0.051	0.009**	-0.007
		(0.028)	(0.005)	(0.000)	(0.041)	(0.003)	(0.018)
	CMA	0.027	0.028***	0.026***	0.074***	0.053***	-0.013
		(0.025)	(0.005)	(0.000)	(0.038)	(0.003)	(0.016)
Hong Kong							
	MKT	0.098***	0.102***	0.087***	0.106***	0.100***	0.109***
		(0.032)	(0.011)	(0.016)	(0.019)	(0.000)	(0.001)
	SMB	0.013	0.129***	0.078***	0.021	0.015***	-0.118***
		(0.050)	(0.017)	(0.025)	(0.030)	(0.000)	(0.002)
	HML	-0.007	0.176***	-0.016	-0.005	-0.020***	0.043***
		(0.056)	(0.019)	(0.028)	(0.033)	(0.000)	(0.003)
	RMW	-0.017	-0.138***	0.007	0.018	0.030***	-0.033***
		(0.061)	(0.020)	(0.031)	(0.036)	(0.000)	(0.003)
	CMA	0.080	0.274***	0.089***	0.078**	0.046***	-0.024***
		(0.056)	(0.019)	(0.028)	(0.033)	(0.000)	(0.003)

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Table 4 (continue)

Region	Model	OLS	RQ	RQ	RQ	RQ	RQ
			0.05	0.25	0.50	0.75	0.95
Singapore							
	MKT	0.091**	0.002	0.114**	0.097***	0.119***	-0.044***
		0.041	(0.004)	(0.050)	(0.011)	(0.008)	(0.027)
	SMB	0.033	0.273***	0.063	0.015	-0.024**	-0.057
		(0.063)	(0.007)	(0.077)	(0.017)	(0.012)	(0.042)
	HML	-0.071	0.183***	-0.044	-0.065***	-0.114***	0.169***
		(0.070)	(0.008)	(0.086)	(0.019)	(0.013)	(0.047)
	RMW	0.010	-0.109***	0.029	0.043**	0.044***	-0.214***
		(0.076)	(0.008)	(0.094)	(0.021)	(0.014)	(0.052)
	CMA	0.014	0.176***	0.010	0.002	0.042***	-0.202***
		(0.070)	(0.008)	(0.086)	(0.019)	(0.013)	(0.047)
Europe							
	MKT	0.011	0.047***	0.013	-0.005	0.003	0.014*
		(0.014)	(0.000)	(0.022)	(0.021)	(0.017)	(0.008)
	SMB	0.015	-0.068***	-0.034	0.017	0.028	0.022*
		(0.016)	(0.000)	(0.035)	(0.033)	(0.027)	(0.013)
	HML	0.122***	0.190***	0.138**	0.114	0.134***	0.042**
		(0.025)	(0.000)	(0.052)	(0.049)	(0.040)	(0.019)
	RMW	-0.004	0.046***	-0.031	-0.002	-0.019	-0.014
		(0.033)	(0.000)	(0.056)	(0.054)	(0.043	(0.021)
	CMA	-0.185***	-0.114***	-0.153*	-0.179	-0.216***	-0.085***
		(0.036)	(0.001)	(0.079)	(0.075)	(0.061)	(0.029)
Germany							
	MKT	0.029	0.099***	0.015	0.025***	0.007	0.001
		(0.021)	(0.001)	(0.029)	(0.002)	(0.019)	(0.011)
	SMB	0.034	-0.078***	0.003	0.028***	0.049	0.082***
		(0.032)	(0.002)	(0.046)	(0.002)	(0.030)	(0.017)
	HML	0.084*	0.061***	0.192**	0.029***	0.058	0.031
		(0.048)	(0.003)	(0.068)	(0.003)	(0.045)	(0.025)
	RMW	0.028	0.124***	0.050	-0.030***	-0.021	0.001
		(0.052)	(0.004)	(0.074)	(0.004)	(0.049)	(0.028)
	CMA	-0.152**	0.020***	-0.261**	-0.076***	-0.113	-0.103**
		(0.073)	(0.005)	(0.103)	(0.005)	(0.068)	(0.038)
France							
	MKT	0.009	0.036***	0.027***	0.015	0.002	-0.005
		(0.014)	(0.004)	(0.000)	(0.027)	(0.025)	(0.005)
	SMB	0.002	-0.016	-0.033	0.008	-0.013	-0.011
		(0.022)	(0.006)	(0.000)	(0.042)	(0.039)	(0.008)
	HML	0.010***	0.096***	0.138***	0.097	0.067	0.035**
		(0.034)	(0.009)	(0.000)	(0.063)	(0.059)	(0.013)
	RMW	-0.023	-0.0007	0.004***	0.003	-0.061	-0.074***
		(0.036)	(0.019)	(0.000)	(0.069)	(0.064)	(0.014)
	CMA	-0.163***	-0.082***	-0.105***	-0.137	-0.161*	-0.113***
		(0.051)	(0.013)	(0.000)	(0.096)	(0.089)	(0.019)

Notes: USA, United States; OLS, ordinary least squared; RQ, regression quantile; Standard error in parentheses; ***, **, *, statistically significant at 1% and 5%.

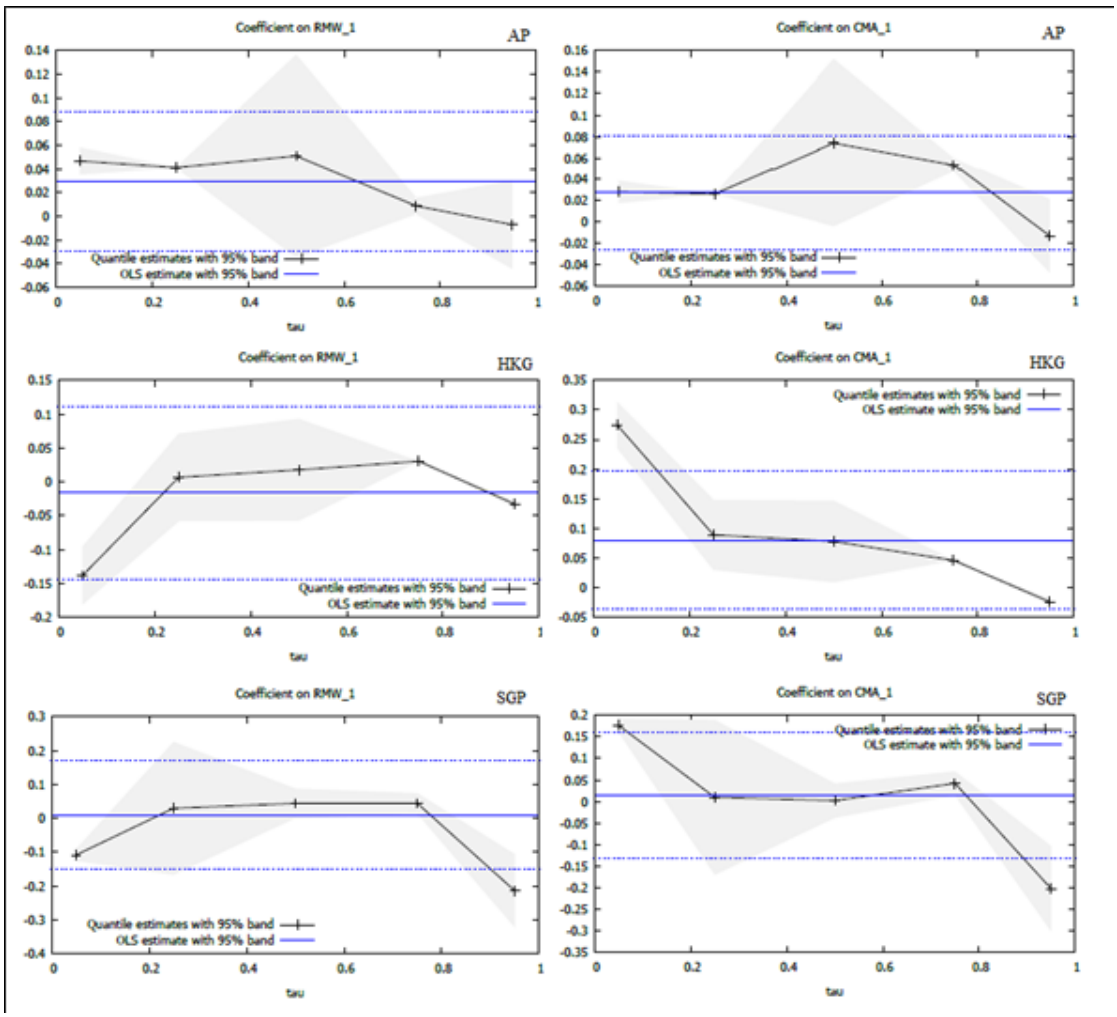
Source: Own Elaboration

In the cases of Canada and the United States, the MKT and HML risk factors contributed positively to forecasting local GDP. The SMB and RMW risk factors return positive effects in the 0.05 and 0.25 quantile, while the negative effect of the CMA risk factor spanned every quantile. The magnitude of the positive coefficients generated by the MKT risk factor for forecasting the GDP of Canada ranged from 0.6% (quantile 0.75) to 7.4% (quantile 0.25). Applied to the United States, the coefficients vary between 2.8% (quantile 0.75) and 9% (quantile 0.25). The positive and statistically significant effect of HML on the GDP

of Canada emerged in three quantiles, with the variation in the coefficient ranging from 3.4% (quantile 0.95) to 12.2% (quantile 0.05). In terms of the GDP for the United States, the positive effect lacks statistical significance but did appear in every quantile, with the variation in the coefficients stretching from 2.4% (quantile 0.75) to 5.5% (quantile 0.05).

For the Asia Pacific region, the positive effects of the five risk factors on both regional GDP and the domestic GDPs of Hong Kong and Singapore emerged in quintiles one to five. The RMW risk factor returned positive coefficients that rose from 0.09% (quantile 0.75, Asia Pacific) to 4.7% (quantile 0.05; Asia Pacific), against average values lacking in statistical significance returned by the OLS calculations. The CMA risk factor generated positive coefficients varying from 2.6% (quantile 0.05, Asia Pacific) to 27.4% (quantile 0.50, Hong Kong). Figure 1 illustrates the effects of the regional RMW and CMA risk factors on conditional quantile GDP behaviour and the OLS returned for Asia Pacific (AP), Hong Kong (HKG), and Singapore (SGP).

Figure 1. Effects of the RMW and CMA risk factors on the regional Asia Pacific market in terms of the quantiles and conditional average of the GDP for the region Asia Pacific (AP), Hong Kong (HKG) and Singapore (SGP)



Source: Own Elaboration

The vertical and horizontal lines respectively represent the risk factor coefficients (independent variables) and the quantiles from 0 to 1. The continuous blue line depicts the OLS estimated coefficient and the respective confidence interval of 95% represented by the

dotted parallel lines. The shaded area identifies the confidence interval for the regression quantile while the vertical, broken black coloured line identifies the coefficients estimated by the regression quantile method. As Table 4 displays, the performance of the RMW and CMA risk factors on regional GDP was positive across the quantiles from 0.05 to 0.75, as was the CMA risk factor for the GDP of both Hong Kong and Singapore. In relation to the RMW risk factor, the positive effect on the GDP of Hong Kong and Singapore emerged in the quantiles from 0.25 to 0.75.

In the case of Europe, the positive and statistically significant effect between 5% and 10% for the regional MKT, SMB, HML, and RMW risk factors on regional GDP ranged across quantiles one to five. The estimates of OLS for the HML risk factor returned positively and statistically significant between 1% and 5% effects for regional and domestic GDP. In the case of regional GDP, the MKT risk factor produced coefficients varying from 1.4% (quantile 0.95) to 4.7% (quantile 0.05). The HML risk factor generated coefficients spanning from 4.2% (quantile 0.95) to 19% (quantile 0.05). Furthermore, the positive performance of the risk factors, SMB and RMW, respectively, on the regional GDP of Europe, stood at 4.6% (quantile 0.05).

In relation to the German GDP, the five regional risk factors returned a positive and statistically significant relationship at 5% for quantiles one to three, contrary to the statistically insignificant measurements (except for HML) returned by the OLS method. The statistically significant and positive performance of the RMW (12.4%) and CMA (2%) risk factors took place in the lowest quantile 0.05.

In the results for the French GDP, the MKT, HML, and RMW risk factors generated positive and statistically significant coefficients at 5% for quantiles one to three. In terms of the MKT risk factor, the magnitude of the coefficients ranged from 2.7% (quantile 0.75) to 3.6% (quantile 0.05). As regards the HML risk factor, the variation in the coefficients varied from 3.5% (quantile 0.95) to 13.8% (quantile 0.25). In turn, the RMW regional risk factor turned in a positive and statistically significant performance at 5% for the 0.25 quantile (0.4%).

5. CONCLUSION

The objective of this paper involved studying whether the MKT, SMB, HML, RMW, and CMA risk factors in the regional asset evaluation models proposed by Fama and French (1993, 2015) capture information that assists in forecasting future economic growth as encapsulated by GDP in the regions of North America, Asia Pacific, and Europe, as well as countries hosting developed and large-scale stock markets for the period between 1991 and 2018. Through the regression quantile technique, we were able to verify that the behaviour of GDP in the low (5%, 25%), median (50%), and high (75% and 95%) percentiles is conditional on the profitability of regional risk factors. The quantile regression empirical results obtained underpin the conclusion that the regional risk factors do contain information able to help in predicting both regional economic growth and that of countries hosting developed and large-scale stock markets even while, as also observed by Fama and French (2017), the regional risk factors act differently in each region. The MKT risk factor is the core component here and impacts positively on every conditional distribution quantile, with the information contained in the SMB and HML risk factors reflected with greater frequency in the lower percentiles of the asymmetric distribution of GDP, while the RMW risk factor impacts on the higher percentiles.

The positive relationship between future economic growth and the three regional risk factors of MKT, SMB, and HML in the model of Fama and French (1993) received further

confirmation in the regions of North America, Asia Pacific, and Europe, as well as at the national level for Canada, the United States of America, Hong Kong, Singapore, France, and Germany. The positive estimates obtained by the multiple regression estimates adopting the five regional risk factors of MKT, SMB, HML, RMW, and CMA in the Fama and French model (2015) received verification by the GDP growth rates for the Asia Pacific region and for the economies of Hong Kong and Singapore. The MKT, HML, and RMW risk factors return a positive relationship favouring economic growth in the region of North America, and nationally for the United States, across at least two distribution quantiles. For Europe, the MKT, SMB, HML, and RMW risk factors generated a positive relationship with regional economic growth as well as national-level growth for both France and Germany.

The results of this study suggest that the profitability returns on the regional risk factors proposed by Fama and French (1993, 1996, 2015) reflect unidentified variables that describe a set of investment opportunities and fall beyond the scope of capture by CAPM.

This empirical study thus contributes to the literature on validating the regional-level asset evaluation models within the context of the relationship between economic growth and the risk factors. The central role played by the MKT risk factor in the regional markets partially reflects the trend towards the integration of stock markets. The profitability rates of regional risk factors for Europe and Asia Pacific stem from twenty countries with developed stock markets. However, this empirical study only approached two countries per region, and there is thus the recommendation for future research to extend this analysis to other countries.

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