PREDICTING FAMA-FRENCH FACTORS BASED ON INDUSTRY RETURNS IN BRAZIL

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How to cite this paper: Gonçalves, M., & Carvalhal, A. (2017). Predicting Fama-French factors based on industry returns in Brazil. *Corporate Ownership & Control, 15(1),* 44-51.
http://doi.org/10.22495/cocv15i1art4

ISSN Online: 1810-3057
ISSN Print: 1727-9232

Received: 21.03.2017
Accepted: 04.07.2017

JEL Classification: G12, G17
DOI: 10.22495/cocv15i1art4

Abstract

There is a vast literature on the predictability of returns based on past information, and many asset pricing models have been tested, such as the Capital Asset Price Model (CAPM) and the three-factor asset pricing model of Fama and French. The purpose of this paper is to answer the question whether Fama-French's size and value factors (SMB and HML) can be predicted by past returns of 16 portfolios formed by companies from the same industry in Brazil. Our analysis controls for different macroeconomic variables and firm characteristics, such as corporate governance practices, size, dividend yield, book-to-market, among others. The analysis reveals that 14 of 16 industries predict SMB one month ahead. Furthermore, the returns of a few industries predict the volatility of SMB and HML up to three months ahead of time. Considering the explanatory capability of the Fama-French model, the results of this research show that Brazilian industry returns contain valuable information for the SMB and HML factors, demonstrating that investors cannot absorb all the information in a timely manner, resulting in their gradual diffusion throughout the market.

Keywords: Predictability, Fama-French Factors, Market Efficiency, Behavioural Finance

1. INTRODUCTION

The predictability of returns based on past information is a subject widely debated in the international financial literature and with several pieces of evidence favourable to this hypothesis. This study investigates whether the past returns of portfolios formed by Brazilian companies of the same economic sector have predictive power for the returns and volatility of the SMB (small minus big) and HML (high minus low) factors of Fama and French's three-factor model.

This research aims to contribute to the Brazilian literature by using returns grouped by economic sectors as predictive variables for SMB and HML. Tsuji (2012) carried out this investigation in the United States, showing that the returns of sector portfolios predict SMB for one month ahead, and the volatility of SMB and HML for up to three months. Tsuji (2008) has obtained similar results in the Japanese market. In a similar study, Hong et al. (2007) have shown that the portfolios of US economic sectors contain predictive information about the stock market movements of that country for a month ahead.

The predictability of returns is a controversial subject since it contradicts the assumption of efficient markets, which considers that market prices reflect all the information available at any time. However, proponents of this hypothesis argue that trading strategies designed to take advantage of the predictability of returns do not generate abnormal returns.

Recent behavioural finance theories, which claim that investors have limited rationality and limited information processing capacity, are often used as justifications for the existence of abnormal returns. Based on these theories, it is possible to expect that new information will spread through the market gradually, with a time lag, rather than instantaneously, causing past returns to contain predictive information about future returns.

This research contributes to the hypothesis of investor irrationality proposed by behavioural finance theories. Should the information contained in the lagged sectorial returns be able to predict the SMB and HML factors, there will be evidence that many investors have limited information processing capacity and therefore cannot extract useful information on all asset prices, especially those in which they are not specialized (Hong et al., 2007), causing new information to be gradually diffused in the market.

This paper studies the Brazilian market by analysing whether portfolios formed by companies from the same economic sector can predict SMB and HML from 1995 and 2012. Our analysis controls for different macroeconomic variables and firm characteristics, such as governance practices, size, dividend yield, book-to-market, among others.

The main contribution of this paper is that, different from previous papers, we innovate and add a corporate governance measure, proxied by the presence of the companies on "Novo Mercado" (New Market), a premier listing segment created in 2001 for firms that decide to adopt voluntarily good governance practices beyond the law. The introduction of the governance component brings new insights for the literature on the predictability of assets returns.

The Brazilian stock market has grown and developed a lot since the 1990's. Factors such as the consolidation of the democratic political system, the stability of the Brazilian economic system with the introduction of the Real plan in 1994, and the fall of inflation and interest rate explain the importance of the Brazilian stock exchange in the last decades. As a result, more investors and academic scholars have applied and tested various economic theories in the county. Carrying out corporate finance studies in emerging markets like Brazil is important because there are already many studies on the subject in developed countries. Moreover, we are able to check whether the similar results are found in different countries and periods.

There are many studies that test the market efficiency hypothesis in Brazil, with mixed results. This paper aims to further enrich this debate by providing new evidence on market efficiency by testing whether portfolios formed by economic sectors contain opportunities to predict the SMB and HML factors. A greater understanding of the behaviour of asset prices and of investors is fundamental for the development of Brazil's capital market. In addition, the possibility of forecasting future returns can be useful for structuring investment strategies and for their subsequent valuations.

The present paper is structured as follows. Section 2 presents the theoretical framework and literature review. Section 3 shows the data used and describes the methodology. Section 4 presents the empirical results, and Section 5 summarizes the main conclusions.

2. LITERATURE REVIEW

The Capital Asset Price Model (CAPM) was developed by Sharpe (1964) and Lintner (1965) using Markowitz's (1959) research. The CAPM describes the return of an asset through the return of the risk-free asset and the market premium multiplied by the beta factor, which measures the sensitivity of the asset's return to the return of a market portfolio. According to this model, the expected returns of the assets are explained only by the beta factor, in a positive linear relation.

Because it is a simple model, it has been widely used in determining the rate of return expected by the assets. However, its validity has been questioned since its creation through empirical tests that showed that much of the change in the return of assets is related to factors other than beta. From these studies, other models were created and incorporated new variables, such as the three-factor model proposed by Fama and French (1993).

The three-factor model was based on previous research by the same authors (Fama and French, 1992), which showed that stock returns could be explained not only by the market premium but also by other variables such as company size, leverage, book-to-market and earning/price ratio. The size effect was identified through the observation that firms with low market capitalization had higher returns than those with high market capitalization, controlling for the respective betas. It was also shown that stock returns were positively correlated with the book-to-market ratio.

Fama and French (1992) concluded that a model containing only the variables size and book-to-market ratio explain stock return better than the CAPM. Based on this evidence, Fama and French (1993) proposed a three-factor asset pricing model, containing beta, firm size (SMB – small minus big) and book-to-market (HML – high minus low). They empirically tested the model and the results indicated that it had greater explanatory power than the model containing only the market factor.

There have been many studies about the Fama and French (1993) three-factor model in many countries, presenting mixed results about their superiority relative to the CAPM. In Brazil, Málaga (2007) and Mussa et al. (2012) found evidence that the three-factor model outperformed the predictability of CAPM. Rogers and Securato (2009) suggested a modified Fama-French model in Brazil, without the use of book-to-market. Rayes et al. (2012) have shown that only the market premium factor is significant. Some reasons for the divergence of results are the periods analysed and the different methodologies for calculating the SMB and HML factors.

Some authors argue that the effects of size and book-to-market are evidence contrary to market efficiency. According to the market efficiency hypothesis, all securities prices fully reflect all available information. As a result, the assets will be traded, on average, at prices equal to their intrinsic values, making it impossible to obtain returns that are greater than the risks incurred. Fama (1991) argues that the market efficiency hypothesis should be tested together with an asset pricing model, since the reason for the abnormal behaviour of returns may be in the market inefficiency or in the model failures.

Theorists advocating the market-efficiency hypothesis argue that the predictable component of returns is a small part of the variations of daily, weekly and monthly returns. In addition, they argue that information and transaction costs eliminate the profitability of trading strategies designed to exploit predictability. Another claim is that anomalies contrary to efficiency hypotheses disappear after they are discovered. However, the existence of these anomalies for a long time can be understood as evidence of market inefficiency.

One of the great critics of the market efficiency hypothesis is Shiller (1981, 2000), who point out the speculative bubbles and that the volatility of theoretical stock prices (determined by the present value of future dividends) are superior to the volatility of dividends. He also shows that stock prices different than the long-term investment potential of companies are evidence of market inefficiency, which is not quickly corrected by investors.

Shiller (2000) discussed several behavioural factors to expose the irrationality of US financial

market. According to Shiller (2000), Kahneman et al. (1982), and Kahneman (2003) people have overconfidence and intuitive judgment, which increase the probability of failures in decision making. Shiller (2000) also points to collective behaviour as one of the precipitating factors of speculative bubbles. According to him, people do not have the capacity to make fully independent judgments. This behaviour was found by empirically proving that individuals tend to go against their own precepts when a large group of people has reached a different judgment from their own.

De Bondt and Thaler (1985) suggest the existence of a reversion to the mean in stock return, noting that a hypothetical portfolio formed by losing shares over the last five years tended to perform well in subsequent intervals of the same duration, and vice-versa. They have concluded that investors react exaggeratedly to unexpected and dramatic events and are initially unaware of key corporate factors such as financial health and the history and resilience of a crisis, leading to a stock price adjustment in the following period.

Hong et al. (2007) investigated whether the returns of portfolios formed by shares of companies of the same economic sector are able to predict the market return between 1946 and 2002 in the United States. The authors grouped the shares into 34 sectorial portfolios and found that 14 of them predicted market movements one month in advance. Sectors related to commodities (for example, oil and metals), of which price shocks historically led the economy to a recession, had negative coefficients, while sectors related to the domestic market (for example, retail and apparel) showed positive coefficients.

Hong et al. (2007) also identified that the ability of sectors to predict market movements is strongly correlated with their ability to predict macroeconomic fundamentals such as GDP growth and industrial output. The authors conclude that the market incorporates the information contained in sectorial returns with lags, sustaining the hypothesis of the gradual diffusion of information. According to them, this is because many investors cannot extract the information contained in the prices of the assets in which they are not specialized.

The study by Hong et al. (2007) was based on the research carried out by Merton (1987), who developed a model of market equilibrium in which each investor has information only on a limited number of shares and, will negotiate only these papers. Merton (1987) used the investor recognition theory of Arbel et al. (1983), by which shares accompanied by a small number of investors and market analysts are traded at a higher expected rate of return, due to the lower distribution among shareholders and the low quality of available information.

Hou and Moskowitz (2005) identified that companies neglected by investors were the ones that presented the greatest delay in responding to new information and that their stock returns had a premium when compared to other stocks, even when controlled by factors such as size, book-to-market, timing and liquidity. The portfolios with the largest response delays were formed by small companies with high book-to-market, low liquidity, high volatility and low recent performance. According to the authors, companies with these characteristics tend to be more neglected, being consistent with the model of Merton (1987).

Hou (2007) has found that returns from large firms predict the return of small firms within the same industry, but not vice versa and that this effect is largely driven by a slow adjustment to negative information. That is, the capacity of the lagged return of the large firm portfolio to predict the return of the small firm portfolio is much greater when the returns of the first portfolio are negative. The author also tested the predictability of firms' returns within the same industry, controlling for firm size, and found a similar result to that of Hou and Moskowitz (2005).

Tsuji (2012) investigated the predictability of returns and volatility of SMB and HML factors in the United States from 1947 to 2002. The author grouped the companies into 30 economic sectors and verified whether the SMB and HML factors could be predicted by the lagged portfolio returns (from 1 to 3 months behind), controlling for several market indicators, such as inflation rate, interest rate, dividend yield and stock market volatility. He showed that the returns of the 30 sectors predicted the returns of the SMB factor for the following month; no sector predicted the SMB two months ahead, and only one sector predicted the SMB three months ahead. In contrast, only 4 of the 30 sectors predicted HML for the following month; no sector predicted HML two months ahead and three sectors predicted HML for the next three months. According to the author, the sectors predict SMB returns better than HML in the US. In addition, the author shows that some sectors contain predictive information about the volatility of SMB and HML, especially for one month ahead.

Tsuji (2008) also conducted similar research in Japan and found that sectorial returns are able to predict SMB and HML. Wu and Shamsuddin (2010) analysed the Australian market and showed that the returns of some sectors are able to predict the market return. This paper performs similar analyses for the Brazilian market.

3. DATA AND METHODOLOGY

Our database consisted of 627 companies listed on the Sao Paulo stock exchange from 1995 to 2012. We started the analysis in 1995 because of the launch of the economic stability plan called Real Plan. We used the Economatica database to collect monthly stock returns, market and accounting variables. The monthly stock returns were adjusted for inflation and dividends.

The methodology used to obtain the SMB and HML factors was analogous to that used in Fama and French (1993). We excluded financial firms from the sample and firms with negative shareholder equity in December of each year. To be included in year t, companies should have monthly data in all months from July of year t through June of year t + 1. The six-month gap between the beginning of the period of analysis of returns (July of year t) and the end of the previous fiscal year (December of t-1) is to ensure that accounting variables have already been made available to the public (Fama and French, 1992, 1993).

At the end of June of year t, the firms that met the selection criteria were classified according to size and book-to-market. To classify them according to size, the companies were ordered by their market value and the median was used to separate the companies into two groups (Small or Big). The classification according to book-to-market occurred through the classification of the firms into three groups (High, Medium or Low) according to the 30th and 70th percentiles. With the intersection between the groups of both criteria, six portfolios were formed: S/L, S/M, S/H, B/L, B/M and B/H. At the end of June of each year, the stock classification process was repeated with the formation of new portfolios, which were maintained until the end of June of the following year.

The monthly returns of each of the six portfolios were calculated by the average stock returns weighted by the respective market value. The monthly returns of SMB were calculated by the difference between the arithmetic mean of the returns of the three small portfolios (S/L, S/M and S/H) and the arithmetic mean of the returns of the three big stock portfolios (B/L, B/M and B/H). On the other hand, the monthly returns of HML were obtained by subtracting the arithmetic mean of the returns of high B/M (S/H and B/H) and low B/M (S/L and B/L).

The methodology used to test the predictability of SMB and HML factors was similar to that used by Tsuji (2012), with some adaptations required by the peculiarities of the Brazilian market. After obtaining the SMB and HML factors, the shares were grouped into 16 sectors: food and beverages; commerce; construction; electronic; energy; finance; manufacturing; information; mining; pulp and paper; oil and gas; chemistry; steel and metallurgy; textile; transport; and vehicles. The use of fewer sectors when compared to Tsuji (2012) is due to the smaller number of companies listed in Brazil than in the United States. In addition, the sectorial segmentation above reflects better the distribution of Brazilian companies by industry, avoiding that sectors are represented by few firms.

The monthly returns of each sector are the average returns of the shares weighted by the respective market value. Table 1 shows the average, minimum and maximum number of companies in each sector.

Table 1. Number of companies by sector

Sector	*Min*	*Max*	*Average*
Food and beverages	10	32	19
Commerce	5	18	11
Construction	1	27	12
Electronic	4	16	8
Energy	15	38	30
Finance	14	35	25
Manufacturing	8	32	20
Information	12	30	20
Mining	2	5	4
Pulp and paper	3	9	6
Oil and gas	3	8	6
Chemistry	10	33	21
Steel and metallurgy	18	39	26
Textile	11	28	20
Transport	2	14	8
Vehicles	12	21	16

To verify if the sectorial portfolios predict the returns of the SMB and HML factors, the following models were estimated:

$$SMB_t = \alpha_i + \lambda_i R_{i,t-k} + A_i Z_{t-1} + \eta_{i,t} \quad (1)$$

$$HML_t = \alpha_i + \lambda_i R_{i,t-k} + A_i Z_{t-1} + \eta_{i,t} \quad (2)$$

where: SMB_t is the return difference between small and large companies in month t; HML_t is the return difference between companies with high and low book-to-market in month t; $R_{i,t-k}$ is the return of the portfolio of sector i lagged k (1 to 3) months in relation to month t; Z_{t-1} is a vector of market indicators lagged at 1 month, and η is the model residual.

The Newey-West method (1987) was used to estimate robust standard errors for the presence of heteroscedasticity and autocorrelation. We used the same market indicators of Tsuji (2012): inflation, credit risk, dividend yield and volatility of market return. The inflation was measured through Consumer Price Index (IPCA). The credit risk was calculated through the difference between the working capital interest rate and the interbank market interest rate (Schor et al., 2002). The market dividend yield is the average dividend yield (dividend of the last 12 months divided by the share price) of the companies in the sample weighted by their market value. Market volatility was calculated by the one-year standard deviation of the stock market index IBrX-100, and the country risk was measured by EMBI + Brazil index. We also add in the regressions an overall corporate governance measure, proxied by the percentage of companies listed on "Novo Mercado" (New Market).

To investigate whether sectorial portfolios contain predictive information on the volatility of SMB and HML factors, we employed the Exponential GARCH (EGARCH). We also estimated other ARCH-models and they presented similar results. The EGARCH models were estimated according to the equations below assuming that standard errors followed a normal distribution. However, the procedure of Bollerslev and Wooldridge (1992) was used so that the significance assessment of the coefficients is robust to the possibility of deviations from the normality of the residuals.

$$SMB_t = \mu + \varepsilon_t \quad (3)$$

$$ln(\sigma^2_{smb,t}) = \omega + \beta ln(\sigma^2_{smb,t-1}) + \alpha \left|\frac{\varepsilon_{t-1}}{\sigma_{smb,t-1}}\right| + \gamma \frac{\varepsilon_{t-1}}{\sigma_{smb,t-1}} + \delta R^2_{i,t-k} \quad (4)$$

$$HML_t = \mu + \varepsilon_t \quad (5)$$

$$ln(\sigma^2_{hml,t}) = \omega + \beta ln(\sigma^2_{hml,t-1}) + \alpha \left|\frac{\varepsilon_{t-1}}{\sigma_{hml,t-1}}\right| + \gamma \frac{\varepsilon_{t-1}}{\sigma_{hml,t-1}} + \delta R^2_{i,t-k} \quad (6)$$

4. EMPIRICAL RESULT

Table 2 shows the descriptive statistics of the returns of SMB, HML and 16 sectors, as well as the average size and B/M for each sectorial portfolio.

Table 2. Descriptive statistics of monthly returns for sectorial portfolios, SMB, HML

	SMB	*HML*	*Food*	*Commerce*	*Construction*	*Electronic*
Average	0,83	0,37	9,23	2,15	1,98	2,84
Median	0,53	0,37	2,32	1,76	1,45	0,44
Std deviation	6,44	8,94	100,47	8,83	12,49	12,08
Min	-17,88	-83,55	-22,17	-24,17	-35,21	-21,40
Max	33,68	25,79	1.433,85	33,05	61,37	63,57
Average firm size	-	-	7.503	2.256	1.043	1.314
Average B/M	-	-	0,40	0,50	1,84	0,47
	Energy	*Finance*	*Manufacturing*	*Information*	*Mining*	*Paper*
Average	2,56	2,30	2,26	2,15	1,98	2,15
Median	2,24	2,24	2,53	1,88	1,16	0,94
Std deviation	9,14	8,46	6,49	9,06	11,40	16,75
Min	-34,37	-25,05	-15,24	-38,35	-30,58	-29,66
Max	49,84	28,21	26,52	36,67	93,01	179,98
Average firm size	5.619	13.359	2.513	11.590	63.931	3.900
Average B/M	1,12	0,74	0,41	0,76	0,64	0,69
	Oil	*Chemical*	*Steel*	*Textile*	*Transport*	*Vehicle*
Average	2,26	5,73	2,48	2,09	2,10	2,55
Median	1,62	2,31	2,35	0,88	1,52	1,50
Std deviation	12,61	44,52	10,09	7,96	11,58	11,69
Min	-50,20	-16,23	-32,77	-25,96	-28,39	-39,10
Max	89,85	626,17	35,41	38,48	53,33	63,44
Average firm size	42.291	2.392	5.042	984	3.556	2.215
Average B/M	0,86	0,61	1,17	1,00	0,35	0,37

Table 3 presents the results of the regressions of SMB returns for months t, t + 1 and t + 2 as a function of each of the 16 sectors. The regression specifications include a constant, SMB lagged one month, sectorial returns lagged by up to three months, inflation, credit risk rate, dividend yield, market volatility and country risk (all lagged one month). For reasons of space, the table shows only the coefficients of lagged sectorial returns, their p-values and the adjusted R^2 of the regressions.

The results of Table 3 indicate that the lagged returns of 14 of the 16 sectors predict SMB returns for month t with a significance level of 5%. When we increase the forecast period, only 3 sectors predict SMB for month t + 1 and 2 sectors predict SMB for month t + 2. Of the market indicators used in the regressions, the country risk was the only one significant at 5% for most sectors and horizons.

Table 4 shows the results of the regressions of HML returns for months t, t + 1 and t + 2 as a function of each of the 16 sectors. The regression specifications include the same variables as in Table 3, but only the coefficients of lagged sector returns, their p-values and the adjusted R^2 of the regressions are reported. The results of Table 4 indicate that the lagged return of only 1 sector predicts HML for month t with a significance level of 5%. For the months t + 1 and t + 2, no sector predicts the returns of the HML.

Table 3. Regression of SMB return as a function of sectorial portfolios

Sector	*Month t*		*Month t+1*		*Month t+2*	
	IND(-1)	*R^2 Adj*	*IND(-1)*	*R^2 Adj*	*IND(-1)*	*R^2 Adj*
Food	0,22*	0,06	0,23*	0,05	-0,04	0,00
p-value	0,00		0,01		0,61	
Commerce	0,17*	0,05	0,11*	0,02	0,00	0,00
p-value	0,01		0,04		0,99	
Construction	0,11*	0,04	0,01	0,00	0,06*	0,01
p-value	0,01		0,63		0,02	
Electronic	0,09*	0,03	-0,02	0,00	0,05	0,01
p-value	0,00		0,53		0,25	
Energy	0,18*	0,07	-0,04	0,00	-0,07	0,01
p-value	0,01		0,35		0,28	
Finance	0,24*	0,10	0,01	0,00	-0,02	0,00
p-value	0,00		0,83		0,79	
Manufacturing	0,28*	0,08	0,22*	0,04	0,08	0,00
p-value	0,00		0,03		0,22	
Information	0,23*	0,10	0,09	0,01	0,00	0,00
p-value	0,00		0,16		0,99	
Mining	0,10	0,02	0,07	0,01	0,04	0,00
p-value	0,09		0,16		0,46	
Paper	0,13*	0,03	0,05	0,00	-0,02	0,00
p-value	0,01		0,33		0,75	
Oil	0,10*	0,04	0,03	0,00	-0,04	0,01
p-value	0,03		0,47		0,43	
Chemical	0,20*	0,07	0,06	0,01	0,01	0,00
p-value	0,01		0,32		0,83	
Steel	0,16*	0,06	0,02	0,00	0,02	0,00
p-value	0,00		0,67		0,65	
Textile	0,19*	0,05	0,09	0,01	0,04	0,00
p-value	0,00		0,18		0,55	
Transport	0,04	0,00	0,03	0,00	0,04	0,00
p-value	0,38		0,39		0,17	
Vehicle	0,10*	0,03	-0,02	0,00	0,09*	0,02
p-value	0,01		0,55		0,02	

Note: coefficients and p-values are reported.
** denotes statistical significance at 5%.*

Table 4. Regression of HML return as a function of sectorial portfolios

Sector	Month t		Month t+1		Month t+2	
	IND(-1)	R^2 Adj	IND(-1)	R^2 Adj	IND(-1)	R^2 Adj
Food	0,04	0,00	-0,20	0,02	0,03	0,00
p-value	0,66		0,27		0,81	
Commerce	0,15*	0,02	-0,14	0,02	0,07	0,00
p-value	0,03		0,10		0,51	
Construction	0,06	0,00	0,00	0,00	0,03	0,00
p-value	0,14		0,99		0,47	
Electronic	0,02	0,00	-0,01	0,00	-0,06	0,01
p-value	0,65		0,60		0,43	
Energy	0,02	-0,01	0,05	0,00	0,10	0,01
p-value	0,81		0,39		0,44	
Finance	0,03	0,00	0,05	0,00	0,14	0,02
p-value	0,65		0,43		0,23	
Manufacturing	0,03	0,00	-0,16	0,01	0,03	0,00
p-value	0,71		0,42		0,68	
Information	0,05	0,00	-0,12	0,01	0,02	0,00
p-value	0,51		0,37		0,91	
Mining	0,08	0,00	0,03	0,00	0,04	0,00
p-value	0,26		0,49		0,64	
Paper	0,09	0,00	0,08	0,00	0,08	0,01
p-value	0,36		0,24		0,35	
Oil	0,08	0,01	0,03	0,00	0,05	0,00
p-value	0,20		0,46		0,61	
Chemical	-0,02	0,00	-0,08	0,00	0,04	0,00
p-value	0,76		0,32		0,63	
Steel	0,07	0,00	0,03	0,00	0,04	0,00
p-value	0,36		0,54		0,54	
Textile	0,10	0,00	-0,07	0,00	0,07	0,00
p-value	0,18		0,26		0,38	
Transport	0,15	0,03	-0,05	0,00	-0,03	0,00
p-value	0,07		0,35		0,65	
Vehicle	0,08	0,01	0,01	0,00	0,03	0,00
p-value	0,09		0,79		0,46	

Note: coefficients and p-values are reported.
** denotes statistical significance at 5%.*

The results of Tables 3 and 4 indicate that sectorial returns predict the returns of SMB better than HML. According to the adjusted R^2 of Table 3, the sector that best predicts SMB for one month ahead is finance, followed by information, and manufacturing. In contrast, the sectors that forecast SMB the worst for a month ahead are mining and transport.

We also investigate whether the forecasting power for SMB and HML is related to the political and economic contexts in the Brazilian market. We split the sample period into two different sub-periods: 1995-2002 and 2003-2012. For the sake of space, we report only the joint hypothesis test that all the coefficients of the 16 sectorial lagged returns are zero.

Table 5 shows the results of the joint significance test for SMB from 1995 to 2002 and from 2003 to 2012. With a significance level of 5%, sectorial returns predict SMB returns for one month ahead in both sub-periods, and also predict for two months ahead in the second sub-period. Therefore, we can conclude that the forecasting power of the sectorial returns on the SMB factor of one month does not change according to the period.

Table 5. Regression of SMB return in different sub-periods

	Month t	Month t+1	Month t+2
	IND(-1)	IND(-1)	IND(-1)
Period: 1995-2002			
Wald test	55,52*	12,40	11,61
p-value	0,00	0,83	0,87
Period: 2003-2012			
Wald test	203,83*	69,40*	27,13
p-value	0,00	0,00	0,08

Note: Wald test statistic and p-values are reported.
** denotes statistical significance at 5%.*

Table 6 shows the results of the joint significance test for HML from 1995 to 2002 and from 2003 to 2012. In the first subperiod, HML is predicted by the 1-month lagged returns of 6 sectors, and, in the second subperiod, by 3-month lagged returns of 5 sectors. The results are consistent with the low predictability of the HML factor in the whole period.

Table 6. Regression of HML return in different sub-periods

	Month t	Month t+1	Month t+2
	IND(-1)	IND(-1)	IND(-1)
Period: 1995-2002			
Wald test	46,07*	15,79	7,38
p-value	0,00	0,61	0,99
Period: 2003-2012			
Wald test	19,04	9,69	67,93
p-value	0,39	0,94	0,00

Note: Wald test statistic.
** denotes statistical significance at 5%.*

Table 7 presents the results of the EGARCH models to predict SMB volatility. Only the values of the coefficients and p-values are reported. Only 1 of 16 sectors contains predictive information of SMB volatility for month t. For month t + 1, no sector predicts SMB volatility, whereas 3 sectors predict SMB volatility for month t + 2.

Table 7. Regression of SMB volatility as a function of sectorial portfolios

Sector	Month t		Month t+1		Month t+2	
	δ	p-value	δ	p-value	δ	p-value
Food	-0,0003	0,7405	0,0011	0,3528	0,0007	0,1012
Commerce	0,0006	0,2092	0,0005	0,3666	0,0002	0,3463
Construction	0,0001	0,1649	0,0001	0,1955	-0,0003	0,1265
Electronic	0,0000	0,9882	0,0000	0,7266	-0,0002*	0,0031
Energy	0,0003	0,1357	0,0002	0,2581	0,0003	0,2726
Finance	0,0006	0,1220	0,0005	0,2878	0,0002	0,2233
Manufacturing	-0,0020*	0,0116	0,0010	0,0958	0,0008	0,2273
Information	0,0005	0,2438	0,0005	0,2412	0,0005	0,2517
Mining	0,0002	0,5956	0,0001	0,7802	0,0004	0,1638
Paper	-0,0002	0,6855	-0,0002	0,6458	-0,0008*	0,0465
Oil	0,0000	0,4965	0,0000	0,5912	0,0000	0,9557
Chemical	0,0001	0,4975	0,0002	0,4099	0,0002	0,4263
Steel	-0,0004	0,2536	-0,0003	0,3921	-0,0002	0,4533
Textile	0,0000	0,8953	0,0000	0,9680	-0,0005*	0,0072
Transport	-0,0003	0,1034	-0,0003	0,1210	-0,0001	0,6052
Vehicle	0,0000	0,7204	0,0000	0,8604	0,0000	0,9333

Note: coefficients and p-values are reported.
** denotes statistical significance at 5%.*

Table 8 shows the results of the EGARCH models to predict HML volatility. Only 4 of 16 sectors contain predictive information of HML volatility for months t and t + 1, whereas 5 sectors predict HML volatility for month t + 2.

Contrary to the predictability of SMB and HML returns, more sectors predict HML volatility better than SML. Moreover, the predictability is not limited only to the horizon t, extending to month t + 2. In summary, we can conclude that the information contained in the returns of certain sectors have the predictive power within 3 months of the volatility for the SMB and HML factors.

Table 8. Regression of HML volatility as a function of sectorial portfolios

Sector	Month t		Month t+1		Month t+2	
	δ	p-value	δ	p-value	δ	p-value
Food	0,0038*	0,0202	0,0039*	0,0453	0,0031	0,0621
Commerce	0,0021*	0,0015	0,0024*	0,0024	0,0021*	0,0125
Construction	0,0001	0,4030	0,0001	0,2494	-0,0001	0,4879
Electronic	-0,0001	0,6748	0,0000	0,9515	0,0001	0,5707
Energy	0,0014*	0,0001	0,0015*	0,0002	0,0017*	0,0007
Finance	0,0014	0,0774	0,0015	0,0575	0,0018	0,0513
Manufacturing	0,0030	0,1391	0,0032	0,1458	-0,0012	0,5017
Information	0,0016*	0,0041	0,0020*	0,0004	0,0018*	0,0394
Mining	0,0003	0,5822	0,0003	0,6732	0,0015*	0,0004
Paper	-0,0001	0,7512	-0,0003	0,5494	-0,0001	0,7730
Oil	-0,0001	0,8205	-0,0001	0,8331	0,0010*	0,0000
Chemical	0,0001	0,4876	0,0001	0,4160	-0,0001	0,8917
Steel	-0,0004	0,6756	-0,0005	0,5189	-0,0005	0,3849
Textile	0,0000	0,9674	0,0002	0,6295	0,0004	0,6190
Transport	-0,0004	0,2991	-0,0005	0,3117	-0,0005	0,2812
Vehicle	-0,0002	0,6688	-0,0002	0,6908	0,0003	0,0803

Note: coefficients and p-values are reported.
** denotes statistical significance at 5%.*

5. DISCUSSION AND CONCLUSION

This research investigates whether the returns of 16 portfolios formed by companies belonging to the same economic sector are able to predict the returns and volatility of Fama and French's SMB and HML factors from 1995 to 2012 in Brazil.

We contribute to the literature of asset pricing by adding a corporate governance measure, proxied by the presence of the companies on "Novo Mercado" (New Market). To the best of our knowledge, this factor was not used in previous papers of predictability of SMB and HML based on industry returns.

We find that 14 sectors predict SMB returns 1 month ahead, but much fewer sectors predict SMB returns two and three months ahead. The predictability of SMB returns for one month ahead was also maintained when the analysis was divided into two different economic sub-periods. The predictability power for HML is weaker than SMB, and only 1 sector predicts HML one month ahead.

With regard to SMB and HML volatility, we find that some sectors have predictive information for SMB and HML up to three months. In contrast to the return analysis, the forecasting results for volatility were better for HML than SML. Only 1 sector contains predictive information of SMB volatility for month t, whereas 4 sectors predict HML volatility for the same period.

Our results are similar to those found by Tsuji (2008, 2012) in the Japanese and US markets. The fact that the sectors predict SMB returns is also in line with Hou and Moskowitz (2005) and Hou (2007), who show that the returns of big companies predict the returns of small companies.

The results of this research serve as an indication that the hypothesis of gradual diffusion of information also applies to Brazil. In fact, this hypothesis may be associated with the lower availability of information to Brazilian investors when compared to the US market and with the smaller investor base present in emerging market such as Brazil when compared to developed markets.

This paper has a few limitations and weakness, which can be addressed in future research. First, our sample covers only Brazilian companies, and it would be interesting to check the results in other countries. Second, our database contains 627 companies, which is a small number when compared to developed countries. Furthermore, our sample period covers from 1995 to 2012, and our results may be biased due to macroeconomics events during that period. Finally, the number and types of industries in Brazil are very limited, which may have affected the predictability of their returns regarding the Fama-French factors.

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