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RESEARCH ARTICLE

And the Winner is ... "CAPM, FAMA and French Three-Factor or Reward Beta"?

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Abstract

The goal of this paper is to estimate and compare three alternative estimating models for predicting asset returns in Brazil and in the United States: 1) Sharpe-Lintner-Mossin CAPM model; 2) Fama and French three-factor model; 3) Reward Beta Model. In accordance with the Fama and French's [1] and Bornholt's [2] methodologies, the tests were carried out on portfolios and applied in two sub-samples of Brazilian and American stocks: The within-sample (1995:07 to 2007:06 in Brazil and 1967:07 to 2007:06 in the United States) and the out-of-sample (2007:07 to 2013:06 in Brazil and in the United States). The results of this study reinforce current perception that the CAPM and the three-factor model fall short to elucidate future returns in both countries. Our results also provide evidence that there is a systematic relationship between the Reward Betas and the excess return of the securities in Brazil and in the United States. Furthermore, the inclusion of the size and book-to-market factors amplifies the explanatory power of the Reward Beta Approach.

Keywords: *Capital Asset Pricing Model; Fama-French three-factor model; Reward Beta Approach*

Introduction

The Capital Asset Pricing Model (CAPM), developed by Sharpe [3], Lintner [4] and Mossin [5] after Markowitz's (1959) conclusions is one of the most widely used asset pricing model in the financial world. This is largely due to its logical, intuitive and straightforward methodology. The model asserts that the covariance of a portfolio return with the market portfolio return (ß) represents a vital part in elucidating changes in the excess portfolio return. However, when the CAPM was unable to explain some anomalies, such as: (1) the positive correlation between the expected returns and earnings to price ratio [6, 7], (2) the fact that small capitalizations had higher expected returns than big capitalizations [8] and (3) the positive correlation between the level of debt and stock returns [9], it was established that other factors rather than the ß were associated to the returns observed amongst the stocks [10].

The landmark model of Fama and French [10] recognized that an overall market factor, a book-to-market ratio (BE/ME) and the firm size (BE) were able to capture a major amount of change in securities´ excess returns. Regardless of the strong empirical evidences in support of the Fama and French three-factor model (FF3FM), Bornholt [11] stated two major problems with the model. First, the method adopted by Fama and French [1] for the construction of the factors that measure the size-effect and the book-to-market effect was empirically defined and ought to be identified ad-hoc. Hence, all the efforts were founded on the examination of the performance of variables adopted by investment analysts, which lacked of a theoretical basis to sustain the use of such variables. Lastly, the practical appeal of the model was limited by the need for a precise assessment of the factors' sensibilities and risk-premiums.

Given the CAPM and the Fama and French three-factor model's limitations, the financial market called for an enhanced methodology to estimate expected returns. In this context, Bornholt [11], proposed the Reward Beta Approach (RBA). The model includes the average risk in pricing the capital assets and diverges from the CAPM by the beta's technique of computation. Yet, whichever the proper model is, the RBA holds the identical value as the average risk beta and avoids the use of the incorrect ß.

Taking into consideration the aforementioned scenario, the goal of this paper is to estimate and compare three alternative estimating models for predicting asset returns in Brazil and in the United States: 1) Sharpe-Lintner-Mossin CAPM model; 2) Fama and French three-factor model, and 3) Reward Beta Model. The size effect and book-to-market found by Fama and French [1] were integrated in the RBA and estimated for North American and Brazilian portfolios during the periods of 1967:07 to 2013:06 and 1995:07 to 2013:06, respectively. Our study extends the asset pricing tests in three ways: (a) We have extended prior studies on the CAPM, FF3FM and RBA with a larger Brazilian dataset than other studies; (b) We have analyzed and compared a developed country and an emerging country. This is relevant, since in the last few years, emerging markets have become gradually more significant to investors because of their fast growing economies; (c) We also have contribute to enhance the knowledge on asset pricing models [12-18].

The remainder of the paper is organized as follows. Section 2 brings a brief review of the previous contributions of the three tested models. Section 3 discusses the data and the construction of the portfolios. Section 4 reports the results of the empirical analysis. The analysis of the outcomes, discussed in Section 4, is divided in three sub-sections: *i*) the first sub-section reveals the estimations of the within-samples betas and factor sensitivities; *ii*) the second sub-section presents the out-of-sample tests; and *iii*) the third sub-section checks the robustness of the models. Section 5 presents the conclusion and the policy implications.

Asset Pricing Models

The Capital Asset Pricing Model (CAPM) endeavors to measure the relationship between the beta of an asset and its equivalent expected return. Developed by Sharpe [3], Lintner [4] and Mossin [5], the model states that the systematic risk of a security can be determined solely by the security's sensitivity to changes in the overall market, which corresponds to the security's market beta. The central implication of this argument relies on the fact that every asset's expected return is a linear function of its systematic risk, or market beta [19]. Considering *i* risk assets in the market, the CAPM can be written as in Equation 1.

$$E(R_i) = R_f + \beta_i[E(R_M \qquad [1]$$

Where denotes the risk free rate, and consists on the expected returns of the asset and of the market, respectively, and

$\beta_i = cov[E(R_i), E(R_M)]/var[$ is the beta of the CAPM.

In the years following the establishment of this model, empirical researchers were able to support the hypothesis of a positive relationship between portfolios betas determined in estimation periods and portfolios returns in subsequent test periods [20-23]. However, in its original version, the CAPM is expressed in terms of expectations. In other words, every variable is written in terms of future values. According to Rogers and Securato [24], the main β corresponds to the future beta of the asset. Elton et al (2004) affirm that systemized data on expectation does not exist on a large scale. So, roughly every test on the CAPM has been developed using past or observed values of the variables. Yet, CAPM supporters affirm that the expectations are, on average, and in its whole, accurate. Hence, in long periods, the real events correspond to the expectations [25] [Equation 2]:

$$\tilde{R}_{it} = E(R_i) + \beta_i[\tilde{R}_{Mt} - E(R_M \qquad [2]$$

The CAPM model is widely used due its simple calculation built on historical data of market and stock prices. However, throughout the years, the empirical discontentment with the CAPM combined with the theoretical appeal of multifactor models – mainly the APT proposed by Ross [26] - led researchers to concentrate their efforts to improve the empirical multifactor models [7,10,27-31].

A response to the poor performance of the CAPM in explaining asset returns was the Fama and French three-factor asset pricing model. Fama and French [1] argue that anomalies not captured by CAPM were identified by the three-factor model. Fama and French [1] asserted that the expected excess returns on stocks could be explained by three factors, such as (1) excess market portfolio return; (2) the monthly difference between the simple average returns of the small and big size portfolios (SMB - small minus big); and (3) the monthly difference between the simple average returns of the high-book-to-market stocks and low-book-to-market stocks (HML - high minus low) [10] The three-factor model of Fama and French may be represented by the expression [3]:

$$E(R_{it}) - R_{ft} = \beta_{im}[E(R_{Mt}) - R_{ft}] + \beta_{is}E(SMB_t) + \beta_{ih}E(HML_t), \quad i\ \{1, \dots, N\} \qquad [3]$$

Where the betas β_{im}, β_{is} and β_{ih} are slopes in the multiple regression.

Taking into consideration that one implication of the expected return equation of the FF3FM is that the intercept in the time-series regression is zero for all assets *i*, the model may be represented by:

$$R_{it} - R_{ft} = \beta_{im}(R_{Mt} - R_{ft}) + \beta_{is}SMB_t + \beta_{ih}HML_t, \quad i\ \{1, \dots, N\} \qquad [4]$$

Where, is the return on asset *i* for month *t*; is the risk-free rate; is the market return; is the size factor; and is the book-to-market factor.

Despite strong evidence in favor of the FF3FM [1,10,19,24,29,32-44], Bornholt [2] condemns the method for two main reasons: (1) the construction of the factors that measure the size and the book-to-market effect must be known ad-hoc, which leads to a shortness of theoretical grounding to support the use of the factors; (2) the practical use of the model is limited by the necessity of having trustworthy estimates of the sensibilities and risk premiums of the factors [24].

In order to offer a better method to estimate expected returns, given the deficiencies of both the CAPM and the three-factor model, Bornholt [2, 11] proposed the Reward Beta Approach (RBA). Even though, reward beta estimates are used to replace the CAPM beta estimates, Bornholt [11] argues that the RBA is consistent with the assumptions of several APT models, even the CAPM.

One important assumption of the CAPM is the fact that the model assumes that all investors choose efficient portfolios based on the average variance [45-47]. Authors such as Bawa and Lindenberg [48], Kaplanski [49] and Bornholt [11] animadvert this principle and develop average risk alternatives based on the APT. Bornholt [1] extends these options, deriving a class of average risk measures based on the APT, including the CAPM as a particular case. The author demonstrates that these measures are consistent with the expected utility theory and with the hypothesis of risk aversion. Bornholt [11] argues that the amount of risk that the investors assume defines the value of the beta, having this to be rewritten as an average risk. So, considering true the hypothesis of the CAPM, the average risk beta in Equation 1 can be rewritten in [5]:

$$\beta_i = \frac{E(R_i) - R_f}{E(R_M) - R_f} \quad \text{or} \quad \beta r_i = \frac{E(R_i) - R_f}{E(R_M) - R_f} \qquad [5]$$

Where the subscript *r* differentiates the conventional measure of the beta from the average risk beta.

According to Bornholt (2007) the correct beta is the average risk given by the premium rate for the asset's risk in relation to the market risk premium. Given that, in finance, the risk premium is seen as a reward for taking additional risk, the rate shown in the equation [5] might be named Beta Premium or Reward Beta. Though the different beta definitions, the average risk models are on the bond market line, as the CAPM [6]:

$$E(R_i) = R_f + \beta r_i [E(R_M \qquad [6]$$

Based on the methodology of the Beta Premium, the expected return of a security entails the estimation of the right side of equation 5. The sensitivity measure $\beta r_i = [E(R_i) - R_f]/[E(R_M$ regarding the market, differently from the traditional $\beta_i = cov[E(R_i), E(R_M)]/var[$ enclosed in the model of equation 6, is supported by the APT's conjectural structure [2]. Yet, prior to estimating and testing the Beta Premium method, its version must be compatible with the version of the market model. Bornholt [11] argues that the risk taken by investors should be seen as the average risk; since this measure is the sum of risk that the investors assume establish the value of the beta. As a result, Bornholt [11] adjusts the CAPM including the beta reward to this model. The equation (2) is complemented with the reward beta in [7]:

$$\tilde{R}_i - R_f = \beta_{ri}[E(R_M + \beta_i[E(\tilde{R}_M) - R_I \qquad [7]$$

The ßj coefficient in the RBA contributes with the volatility of the asset's *i* return and controls the covariance between the asset and market's return, but it does not influence the predictable value (except if $\beta_{ri} = \beta_i$). Hence, even though the value of the CAPM's beta may be used ex-post to adjust the data to the model, it is not ex-ante relevant to estimate predictable returns. In his research, Bornholt [11] found that the RBA presented the highest efficiency when compared to the CAPM and three-factor model in estimating expected returns in the American stock market. In other studies, such as Tseng [50], Rogers and Securato [24], Rodriguez and Maturana [51] the results concerning the efficiency of the Reward Beta Approach presented some controversy.

Empirical Procedures

In order to estimate and compare the CAPM, Fama and French three-factor model and the Reward Beta Model, this research used two sets of data. The first set refers to the USA portfolios - obtained directly from the Fama and French website. The data covers a period from 1967:07 to 2013:06, which was further divided into the estimation (1967:07 to 2007:06) and post-estimation (2007:07 to 2013:06) period. The second set of data refers to the Brazilian portfolios, which were constructed using the entire population of stocks listed in the São Paulo Stock Exchange from 1995:07 to 2013:06. Again, the period was divided into estimation (1995:07 to 2007:06) and post-estimation (2007:07 to 2013:06). We have decided to select the period after 1994 since the Brazilian economy has achieved more stability with the adoption of Real Plan in July of 1994.

The financial companies were debarred from the sample because their high level of leverage does not have similar connotation for non-financial companies [1] Moreover, stocks were disqualified if they did not present: (1) uninterrupted monthly quotations for a 12-month period subsequent to the construction of the portfolios - with a 15-day tolerance; (2) market value in December 31st and June 30th - with a 15-day tolerance; and (3) positive equity in December 31st. It is relevant to mention that the months of August and September of 2008 were taken away from the Brazilian sample, since their values behaved as outliers. This period corresponds to the peak of what it known as a world financial crisis, which began in 2007. Yet, since the sample size in the USA scenario is large, the data did not present outliers. In this case, the mean score provided a better measure of the central tendency.

The continuously compounded monthly returns - adjusted for income, including dividends and deflated by IGP-DI - of the stocks were calculated through natural logarithm of the stock prices. The proxy for the risk-free rate of return is the savings account. The proxy for the market portfolio is the Ibovespa Index.

The Brazilian portfolios were constructed from six (2 by 3) weighted portfolios by ME and BE/ME. The six portfolios used to estimate the factors SMB and HML were built at each end of June, subsequent to the following steps: (1) at the end of June of each year *t* Brazilian stocks were sorted by the ME and split by the median in two groups; (2) the BE/ME breakpoints in the 2 by 3 portfolios are the 30th and 70th percentiles of BE/ME, as in Fama and French [1]. BE/ME and the market cap were obtained at the end of each December (*t-1*). Finally, the six portfolios based on ME and BE/ME ratios were constructed with approximately the same number of stocks.

Once the six portfolios were formed, twenty five (5 by 5) portfolios were built in order to test the models considered in the study. The methodology used to construct the twenty five portfolios is comparable to the one adopted to build the six portfolios, except for the fact that the variables ME and BE/ME on steps 1 and 2 were divided into five subgroups with analogous number of stocks.

The methodology used to structure the six portfolios (to set the factors) and the twenty five portfolios (to test the models) differs slightly from Fama and French [1] and Bornholt [11], but follows the procedures used by Rogers & Securato [24] and Gabriel & Rogers [52]. The authors built the portfolios using the intercessions between two (five) portfolios formed by ME and the three (five) formed by the BE/ME ratio. As a result only two stocks could exist in a particular portfolio, given that the intercessions were random. In Fama and French [1] and Bornholt [11] this risk was very low, considering that in 1990, they had 4,419 stocks in their database.

In Brazil, the small number of stocks led to the following limitations: (1) if fewer, but more diversified portfolios, were adopted, there would be fewer observations for the second-step of the cross-section regressions test; (2) if more portfolios, and thus more observations for the second-step of the cross-section regressions test were adopted, there would be the risk of having few diversified portfolios, which could weaken the APT models. Hence, in this study, the intercession was not random, but it was defined with the purpose of balancing the number of stocks in the portfolios [24,52].

In line with Bornholt [11], the usefulness of the estimates of the RBA and the CAPM relies on how similar the risks between the portfolios are. Fama and French [1, 32] avow that if the stocks prices are rational, the effects of ME and BE/ME are supposed to be factors of hidden risk. If the justification of the risk based on these two effects is accepted, then the portfolios formed based on ME and BE/ME are formed of stocks with comparable risks, and could be utilized to estimate the Reward Beta and the CAPM's beta [11].

Elton et al [25] discuss a number of tests' procedures on the CAPM and comparable models. In effect, the tests involve the use of a time-series regression (first-step) to estimate the betas, and the use of a cross-section regression (second-step) to test the hypothesis resultant from the models. Thus, the betas (sensibilities) estimated in the first-step are used as explanatory variables in the second-step cross-section regressions. This study uses the mentioned approaches to compare the FF3FM, CAPM and RBA [11, 24, 52].

Results and Discussion

Estimations of the Within-Sample Betas and Factor Sensitivities

The outcomes on Table 1 reveal the parameter estimates of the CAPM, risk premium and reward betas related to the 25 monthly portfolios constructed based on the ME and the BE/ME for Brazil and the USA. Panel *A* (Brazil) and Panel *B* (USA) of Table 1 present the average monthly percentage excess returns on the 25 Fama and French based on market value (ME) and book-to-market equity (BE/ME) weighted portfolios for the within-sample period 1995:07 to 2007:06 in Brazil and 1967:07 to 2007:06 in the United States. Panel *B* points out the conventional CAPM beta estimates and Panel *C* reveal the Reward Betas estimates.

Table 1: Monthly risk premium, CAPM's beta and reward beta of the within sample for the 25 portfolios based on ME and BE/ME, in accordance with Fama and French's methodology.

	Book-to-market (BE/ME) - BRAZIL						Book-to-market (BE/ME) - USA				
Size (ME)	**Low**	**2**	**3**	**4**	**High**	**Size (ME)**	**Low**	**2**	**3**	**4**	**High**
Panel A: Risk Premium (% Montlhy Average)						*Panel A: Risk Premium (% Montlhy Average)*					
Small	0.37	0.10	0.65	1.33	0.71	**Small**	0.12	0.76	0.83	1.01	1.14
2	-0.28	1.66	2.06	1.29	1.33	**2**	0.34	0.64	0.86	0.95	0.99
3	-0.71	-1.34	-0.26	0.81	0.89	**3**	0.40	0.70	0.71	0.82	1.04
4	0.29	0.20	2.58	0.52	1.77	**4**	0.51	0.52	0.73	0.81	0.86
Big	0.15	-0.63	-0.19	2.18	1.34	**Big**	0.39	0.55	0.50	0.58	0.64
Panel B: Beta of the CAPM						*Panel B: Beta of the CAPM*					
Small	0.46	0.66	0.64	0.76	0.73	**Small**	1.45	1.22	1.07	0.97	1.01
2	0.49	0.37	0.36	0.49	0.57	**2**	1.44	1.17	1.02	0.95	1.03
3	0.29	0.33	0.28	0.33	0.33	**3**	1.36	1.10	0.97	0.89	0.98
4	0.48	0.42	0.49	0.36	0.39	**4**	1.26	1.07	0.97	0.90	0.97
Big	0.64	0.51	0.55	0.51	0.45	**Big**	1.01	0.95	0.85	0.78	0.81
Panel C: Reward Betas						*Panel C: Reward Betas*					
Small	0.40	0.11	0.70	1.44	0.77	**Small**	0.25	1.61	1.76	2.15	2.41
2	-0.30	1.80	2.24	1.40	1.44	**2**	0.72	1.37	1.83	2.02	2.09
3	-0.77	-1.45	-0.28	0.87	0.96	**3**	0.85	1.49	1.50	1.74	2.20
4	0.32	0.21	2.80	0.56	1.92	**4**	1.07	1.11	1.55	1.73	1.81
Big	0.17	-0.68	-0.21	2.36	1.45	**Big**	0.82	1.16	1.05	1.23	1.36

Note: The within-sample comprises the period from 1995:07 to 2013:06 in Brazil and 1967:07 to 2013:06 in the USA. Monthly returns were used to compute the excess returns according to the methodology of Fama and French [1]. The CAPM's betas of the portfolios were obtained through the time-series regressions of the monthly risk premiums making the regression of the monthly risk premiums over the monthly excess of market return, where Ibovespa (Brazil) and S&P500 (USA) are proxies of the market portfolio and the Brazilian Savings Account and T-bills (USA) are proxies of risk-free rate of return. Other proxies of market and risk-free were tested, but there were no significant differences amongst all of them. Thus Ibovespa/S&P500 and Brazilian Savings Account/T-bills were chosen as the proxies of this study. The reward betas of the portfolios consist on a ratio between the risk premium (monthly average) and the average of the excess of market return of the within-sample.

Exploring the results of Table 1, it is feasible to identify the evidences that the betas of Brazil's CAPM do not seem to be able to recognize the risk related to the companies' sizes since all betas linked to small companies present values inferior than one. Similar results were found by Rogers and Securato [24], Gabriel and Rogers [52] and Medeiros [43]. Additionally, some companies presented negative risk premiums and as a result, negative reward betas. On the contrary, when we explore the CAPM betas of USA, in general, they seem to capture the risk associated with companies´ sizes, since the values were higher than one, which means that they are riskier than the market.

Table 2 adopts the FF3FM to describe the within-sample sensitivities of the returns of the 25 portfolios adopted in this study. The results disclose that the every coefficient of (Rm-Rf) is positive, in Brazil and the United States. Additionally, the coefficients of (Rm-Rf) are higher in the USA, indicating higher risks. Table 2 also reveals that, in general, when the betas of the market factor are controlled by size and book-to-market, they reveal better estimates than the ones obtained in Table 1. Yet, the (R_m-R_f) factors in Brazil and in the USA show the sensibility of large portfolios towards the factor BE/ME. Besides, when controlled by the size and book-to-market effect the beta seem to capture the differences in portfolios risks – when comparing Panels B and C (Table 1) with Panel *A* of Table 2 [24].

Table 2: Sensitivities of the three factors for the 25 portfolios obtained subsequent to ME and BE/ME, and calculated in the time series regression of the within-sample

	Book-to-market (BE/ME) - BRAZIL					Book-to-market (BE/ME) - USA				
Size (ME)	**Low**	**2**	**3**	**4**	**High**	**Size (ME)**	**Low**	**2**	**3**	**4**	**High**
Coeficientes of ***b*** (Rm-Rf)						*Coeficientes of* ***b*** (Rm-Rf)					
Small	0.58	0.81	0.77	0.94	0.89	**Small**	1.07	0.95	0.92	0.89	0.98
2	0.73	0.57	0.49	0.65	0.75	**2**	1.13	1.03	0.98	0.97	1.07
3	0.50	0.51	0.43	0.44	0.46	**3**	1.08	1.06	1.02	1.00	1.11
4	0.68	0.59	0.69	0.49	0.57	**4**	1.05	1.11	1.08	1.04	1.17
Big	0.87	0.72	0.72	0.59	0.58	**Big**	0.95	1.04	0.98	1.00	1.06
Coeficientes of ***s*** (SML)						*Coeficientes of* ***s*** (SML)					
Small	0.01	-0.07	-0.15	-0.04	-0.02	**Small**	1.37	1.33	1.11	1.02	1.09
2	0.61	0.64	0.31	0.27	0.17	**2**	0.97	0.88	0.76	0.72	0.85
3	0.50	0.41	0.41	0.13	0.27	**3**	0.73	0.52	0.44	0.40	0.54
4	0.31	0.15	0.27	0.11	0.52	**4**	0.38	0.23	0.17	0.22	0.23
Big	0.31	0.33	0.17	-0.15	0.07	**Big**	-0.27	-0.21	-0.22	-0.20	-0.10
Coeficientes of ***h*** (HML)						*Coeficientes of* ***h*** (HML)					
Small	0.00	0.01	0.03	0.05	0.12	**Small**	-0.34	0.05	0.29	0.45	0.69
2	-0.12	-0.01	0.06	0.05	-0.09	**2**	-0.39	0.17	0.42	0.59	0.78
3	-0.52	-0.19	-0.06	-0.05	0.06	**3**	-0.45	0.23	0.51	0.67	0.84
4	-0.23	-0.26	-0.27	-0.18	0.04	**4**	-0.44	0.28	0.50	0.62	0.84
Big	-0.06	-0.25	-0.05	0.15	0.00	**Big**	-0.40	0.16	0.31	0.63	0.79

Note: In the time series regressions, the monthly risk premiums (R_j-R_f) are calculated against (R_m-R_f), SML and HML of the within-sample from 1995:07 through 2013:06 in Brazil and from 1967:07 to 2013:06 in the United States. (R_m-R_f) represents the difference between Ibovespa and Savings Account (In Brazil), and S&P500 and T-Bill (in the USA). Other proxies of market and risk-free rate of return were tested, but there was no significant difference amongst all of them. SML and HML are the returns of the Fama and French's factors calculated in the within-sample for Brazilian and American stocks.

Table 2 also reveals that concerning the factor HML, in Brazil, the sensibilities do not demonstrate a pattern because the estimate sensibilities can be either positive or negative, even though the results indicate that the big portfolios hold a higher sensibility with the factor BE/ME. In the USA, only the portfolios with low (BE/ME) present negative results. Lastly, the sensibilities of the SML factor are higher for companies that hold low BE/ME, in Brazil and in the USA.

Out-of-Sample Tests

The out-of-sample tests with the CAPM, RBA and FF3FM, as well as the factors market (R_m-R_f), size (SML) and book-to-market (HML) were done and analyzed in this section. Results in Table 3 allow us to establish that the estimated betas for the CAPM + Intercept, Reward Beta + Intercept, and FF3FM + Intercept, in Brazil and in the United States, are not significantly different from zero. Thus, CAPM, FF3FM and RBA can't be unmistakably discarded. Although, we can't undoubtedly reject the models with interceptions in Brazil (Gabriel & Rogers, 2013) and in the USA, there is enough evidence to assert that there are other factors that influence the cross-section of stock returns in both markets.

Analyzing the CAPM + Intercept, Reward Beta + Intercept, and FF3FM + Intercept on the basis of the adjusted R^2 criterion, we can assert that the three-factor model + Intercept is the most powerful model to explain the common variation in stock returns in Brazil and in the United

Table 3:Cross-section regressions of the portfolio monthly risk premiums (Rm-Rf) obtained in out-of-sample, on CAPM's betas, Reward Beta and the sensibilities of FF3FM for 25 portfolios based on ME and BE/ME, and obtained through the within-sample regression

BRAZIL

Model	Intercept	Reward Beta	CAPM Beta	*b* (*Rm-Rf*)	*s* (*SML*)	*h* (*HML*)	*R²*	*F-Statistic*
CAPM + Intercept	0.46		-0.61				1.3%	0.31
	(0.45)		(-0.38)					
3 Factors + Intercept	1.05			-1.12	-1.15	-1.28	13.8%	1.12
	(1.05)			(-0.91)	(-1.51)	(-1.08)		
Reward + Intercept	0.41	0.19	-0.79				12.4%	1.56
	(0.39)	(1.46)	(-0.50)					
CAPM			0.29				1.3%	0.32
			(0.25)					
3 Factors				0.29	-0.69	-1.37	6.5%	0.76
				(0.36)	(-0.80)	(-1.14)		
Reward		0.20	0.00				6.9%	1.69
		(1.60)	(0.00)					
Reward Augmented		0.29	0.33		-0.85	-2.44	25.0%	2.34*
		(2.75)**	(-0.15)		(-0.99)	(-1.97)		

UNITED STATES

Model	Intercept	Reward Beta	CAPM Beta	*b* (*Rm-Rf*)	*s* (*SML*)	*h* (*HML*)	*R²*	*F-Statistic*
CAPM + Intercept	0.23		0.28				4.3%	1.04
	(0.28)		(0.54)					
3 Fatores + Intercept	-0.42			0.88	0.09	-0.02	8.1%	0.62
	(-0.54)			(0.96)	(0.35)	(-0.07)		
Reward + Intercept	-0.42	0.22	0.60				1.7%	0.19
	(-0.53)	(0.84)	(0.91)					
CAPM			0.49				4.3%	1.09
			(0.71)					
3 Factors				0.48	0.08	-0.02	7.5%	0.89
				(0.78)	(0.29)	(-0.09)		
Reward		0.14	0.31				19.6%	5.62*
		(0.60)	(0.62)					
Reward Augmented		0.34	0.17		-0.06	-0.38	23.9%	2.20*
		(2.21)*	(0.27)		(-0.24)	(-1.37)		

Note: The out-of-sample comprises the period from 2007:07 to 2013:06. The CAPM's Beta, the Reward Beta and the sensibilities of FF3FM for the 25 portfolios based on ME and BE/ME, calculated in Table 1 and 2, are used as explanatory variables in the cross-section regressions. In these regressions the dependent variables are the monthly averages of the portfolios' risk premiums calculated from 2007:07 to 2013:06. In the table, the coefficients of the regressions and the value of the t-statistics (in parentheses) are reported. ** and * indicate statistical significance at the 0.01 and 0.05 levels, respectively. R^2 is the correlation coefficient between their predicted values and real outcomes, F-Statistic tests the joint significance of the model´s parameters. The standard errors used to compute the t-statistics were calculated according to the technique of Fama and Macbeth [21].

States (R^2_{Brasil}=13.8% and R^2_{USA} =8.1%). However, the mentioned models are not statistically significant (F-Statistics < 2.0). Besides, the Reward Beta and the CAPM, both with intercept, are also not statistically significant

The next three regressions demonstrate that none of the coefficients of CAPM, FF3FM or RBA models are statistically significant to explain the excess return of the securities in Brazil or in the USA. However, the RBA in the USA market shows a significant F-statistic (5.62) with a R^2=19.6%.

The last regression on Table 3 displays the tests of the Reward Beta Model Augmented with the ME and BE/ME factor sensitivities (Bornholt, 2007; Rogers & Securato, 2009; Gabriel & Rogers, 2013). Similarly to the results of Gabriel and Rogers (2013), the coefficient of RBA was significant in Brazil (t=2.75), as well as in the USA (t=2.21) at 5% level. Above and beyond, both RBA display a fine R^2 (R^2_{Brasil}=25.0% and R^2_{USA}=23.9%).

Robustness

Table 4 summarizes several endpoints of within-sample periods. This research adopted the methodology of increasing the within-sample by 6 months from 2003:06 until 2008:06. Because of the constraint in space, the research will detail only the results of the RBA applied in Brazil and in the United States.

Results in Table 4 allow us to establish the importance of the RBA in explaining the cross-section average returns in both Brazil and the USA. The results are consistent with the ones obtained by Bornholt [11], since the RBA outperforms CAPM and the FF3FM during the entire period of study, except 2006:12. When the RBA is applied in the Brazilian scenario, we observe that the outcomes are similar to the ones obtained by Rogers and Securato [24] and Gabriel and Rogers [52], at least when the procedures consider the end within-samples 2004:06; 2004:12; 2005:06; 2005:12; 2006:06; 2006:12; 2007:06; 2008: 06. It is relevant to mention that, even tough, the RBA was not statistically significant on 2003:06; 2003:12 and 2007:12, the CAPM and FF3FM were also not significant.

Bornholt [11] supports the use of large samples with the purpose of diminishing any possible bias. Albeit the sample size of Brazil adopted in this research is considerably smaller than the one used by Bornholt [11], the RBA is robustly sustained by the empirical results stated in this paper. Further evidence of this statement is demonstrated in Table 4 considering that when the sample size became larger, the F-Statistic also became, in general, larger. The mentioned statistic values indicate the statistical significance of the RBA's adoption as a whole. In 2006:12, 2007:06, 2007:12 and 2008:06 the F-Statistic with the Brazilian data assumed values of 2.66; 2.34; 1.93 and 2.63, in that order. The correspondents' values of R^2 are 27.5%; 25.0%; 22.1% and 27.3%. In the U.S., during the same periods the F-Statistic assumed values of 1.27; 2.20; 5.27 and 8.62, respectively. The correspondents' values of R^2 are 15.4%; 23.9%; 43.0% and 55.2%. The R^2 values achieved here are very similar to the ones pointed out by Bornholt [11] in the U.S market (44% and 35% in 2006 and 2007, respectively).

Table 4:Several endpoints of within-sample periods from 2003:06 through 2008:06, the within-sample Reward Betas, CAPM betas and FF3FM sensitivities for the 25 portfolios of FF formed on ME and BE/ME are recalculate and used as explanatory variable in the out-of-sample cross-section regressions.

BRAZIL

End of Within Period	Reward Beta Augmented	CAPM Beta	*b*	*s*	*h*	R^2	F-Statistic
June 2003	0.03 (1.61) *	1.65 (2.41)*		0.89 (1.26)	-1.07 (-1.07)	0.20%	0.02
December 2003	0.11 (1.80) *	1.17 (1.70)		1.06 (1.49)	-0.72 (-0.70)	2.10%	0.15
June 2004	0.12 (2.23)*	1.27 (1.78)		1.41 (1.86)	-0.71 (-0.67)	3.20%	0.23
December 2004	0.17 (2.46)*	0.89 (1.23)		1.24 (1.54)	-0.31 (-0.29)	3.40%	0.25
June 2005	0.15 (2.39)*	1.25 (1.72)		0.94 (1.1)	-0.29 (-0.26)	0.60%	0.04
December 2005	0.27 (2.73)**	0.81 (1.15)		1.04 (1.13)	-1.01 (-0.89)	9.00%	0.69
June 2006	0.27 (2.64)**	0.72 (0.99)		0.36 (0.41)	-1.84 (-1.60)	11.10%	0.87
December 2006	0.37 (3.01)**	0.17 (0.23)		0.46 (0.47)	-2.01 (-1.73)	27.50%	2.66*
June 2007	0.33 (2.75)**	-0.12 (-0.15)		-0.85 (-0.99)	-2.44 (-1.97)	25.00%	2.34*
December 2007	0.30 (2.46)	0.13 (0.16)		-0.93 (-1.01)	-3.13 (-2.42)*	22.10%	1.98
June 2008	0.30 (2.39)*	-0.05 (-0.05)		-0.79 (-0.8)	-4.05 (-3.70)**	27.30%	2.63*

Cont. Table 4:Several endpoints of within-sample periods from 2003:06 through 2008:06, the within-sample Reward Betas, CAPM betas and FF3FM sensitivities for the 25 portfolios of FF formed on ME and BE/ME are recalculate and used as explanatory variable in the out-of-sample cross-section regressions.

UNITED STATES

End of Within Period	Reward Beta Augmented	CAPM Beta	*b*	*s*	*h*	R^2	F-Statistic
June 2003	0.26** (2.88)**	0.42 (1.05)		0.05 (0.25)	-0.05 (-0.27)	40.5%	4.76*
December 2003	0.22* (2.29)*	0.37 (0.88)		-0.04 (-0.18)	-0.05 (-0.24)	26.3%	2.50*
June 2004	0.22* (2.22)*	0.37 (0.82)		-0.05 (-0.25)	-0.07 (-0.34)	24.4%	2.26*
December	0.25*	0.30		-0.08	-0.15	22.2%	2.00*

2004	(2.32)*	(0.65)	(-0.39)	(-0.73)		
June	0.25**	0.34	-0.05	-0.22	16.7%	1.41
2005	(2.24)*	(0.69)	(-0.22)	(-0.99)		
December	0.27	0.30	-0.06	-0.22	18.9%	1.63
2005	(2.21)*	(0.59)	(-0.25)	(-0.95)		
June	0.26	0.34	-0.10	-0.29	15.0%	1.23
2006	(2.10)*	(0.62)	(-0.43)	(-1.21)		
December	0.27	0.29	-0.07	-0.33	15.4%	1.27
2006	(1.92)	(0.50)	(-0.29)	(-1.29)		
June	0.34	0.17	-0.06	-0.38	23.9%	2.20*
2007	(2.21)*	(0.27)	(-0.24)	(-1.37)		
December	0.41	0.18	0.06	-0.29	43.0%	5.27*
2007	(2.48)*	(0.26)	(0.22)	(-0.95)		
June	0.40	0.41	0.10	-0.35	55.2%	8.62*
2008	(2.49)*	(0.58)	(0.35)	(-1.04)		

Note: The out-of-sample covers several periods. The CAPM's Beta, Reward Beta and the sensibilities of FF3FM for the 25 portfolios based on ME and BE/ME are used as explanatory variables in the cross-section regressions. In the regressions, the dependent variables are the monthly averages of the portfolios' risk premiums calculated in out-of-sample. ** and * indicate statistical significance at the 0.01 and 0.05 levels, respectively. R^2 is the square of the sample correlation coefficient between their predicted values and real outcomes. The standard errors used to calculate the t-statistics (in parentheses) were obtained based on the procedures of Fama and Macbeth [21].

As stated earlier, August and September of 2008 were not considered due the fact that they behave as outliers. The main reason of this behavior is the fact that the peak of financial crisis of 2008 occurred around this time. However, one should not be concerned with this decision because we have tested the results with and without the outliers and the outcomes were similar. In other words, the analyses obtained in this research reveal that the elimination of outliers did not produce a significant change in the *t*-statistics between the sample with outliers and the sample with no outliers. Orr, Sackett, and DuBois [53] and Zimmerman [54] present arguments in favor of the elimination or adjustment of outliers. Osborne and Overbay [55] advocate that outliers amplify error variance. Hence, it would be suitable to exclude them [56].

Conclusion and Policy Implications

A model's aptitude to predict future returns is an essential factor in helping managers and investors make wise decisions about their financial investments. This study tested the Reward Beta model in Brazil and in the United States and compared the results to the Sharpe-Litner-Mossin version of the CAPM and the Fama and French three-factor model. The methodology adopted followed Fama and French's [1] and Bornholt's [11]. The tests were applied in two sub-samples of Brazilian and American stocks: the within-sample (1995:07 to 2007:06 in Brazil and 1967:07 to 2007:06 in the United States) and the out-of-sample (2007:07 to 2013:06 in Brazil and in the United States).

The results of this study reinforce current perception that the CAPM and the three-factor model fall short to elucidate future returns in both countries. Our results also provide evidence that there exists a systematic relationship between the Reward Betas and the excess return of the securities in Brazil and in the United States. Furthermore, the inclusion of the size and book-to-market factors amplifies the explanatory power of the Reward Beta Approach. This finding is consistent for different subperiods in both countries. Thus, the use of the Reward Beta Approach to predict stock returns seems to be the most appropriate.

The fragile performance of the CAPM in this research corroborates the theoretical and empirical problems [11] of the model. Bornholt [11] states that one empirical benefit of the Reward Beta Approach over the Fama & French model is the fact that the RBA deals with the interactions between size and book-to-market factors automatically. As a result, it boosts the capacity of the model to forecast stock returns consistently.

Despite the results, a few limitations must be stated. In Brazil, the sample size in terms of years investigated and in the number of companies used to build the portfolios, may be a problem. Bornholt [11] mentioned that the reduced number of companies in the construction of the portfolios may lead to low diversity portfolios, resulting in damages when the APT models are estimated. Furthermore, the reduced number of companies in the sample reveals the low liquidity and high concentration of the Brazilian stock market. Bornholt [11] argues the estimation of the CAPM's beta and the reward beta can be biased in small samples because these models are expressed in terms of expectations, and on average, these might be inaccurate in short periods. This limitation in the Brazilian market is not applicable to the United States market, since that data has been available since 1967. This gives more reliability to the results.

Regardless of the limitations of available data, the results of this study have proven that the Reward Beta Approach is the most preeminent test to predict stock return in both the Brazilian and in the American markets. The passage of time will only create more information and show the relevance of this model to the asset pricing theory.

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