Pricing Assets with Fama and French 5-Factor Model: a Brazilian market novelty

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ABSTRACT

Following the Fama and French three-factor model, the authors proposed in 2014 a five-factor model (FF5F). They find that the FF5F performs better than the previous one in capturing risk in the cross-section of stock returns. Even though the model is not consolidated and their work is still a working-paper, we bring these tests early in the game to the Brazilian market, in order to promote and advance understanding of similarities and divergences of our market with the American stock market. Our results show that the FF5F model performs better than previous work in three-factor model. However, market, SMB and HML factors still perform similarly as previous works indicated.

Key words: Asset pricing. Risk factors. Three-factor model. Five-factor model

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1 Introduction

Following a series of works that challenged the validity of the Capital Asset Pricing Model (CAPM) of Sharpe (1964) and Lintner (1965), several asset-pricing models have been proposed. These models attempt to capture the risk and return relationship and explain the cross-section of average stock returns. However, most models are not completely successful given that anomalies are frequently uncovered in empirical tests. When a new risk-return relationship not explained by the CAPM is uncovered, these variables are called anomalies (Fama & French, 2008).

Previous works have determined, empirically, the statistical significance of variables such as: market capitalization (size), book-to-market (B/M), investment in capital expenditures (investment) and operating profitability. Banz (1981) found the size effect which indicates that smaller firms tend to have higher returns. Fama and French (1992) determined the value effect, which in turn uses the book-to-market indicator and establishes a positive relationship between this variable and expected returns. Titman, Wei and Xie (2004) shows that firms which increase capital investment tend to have future negative risk-adjusted returns. Finally, Novy-Marx (2013) uncovers a positive relationship between profitable firms and expected returns.

In order to determine whether variables like these uncover some unexplained relationship it is necessary to test their ability to predict risk-adjusted (abnormal) returns. Then, these tests must be done against an asset-pricing model such as the CAPM or the Fama and French (FF) three-factor model.

After thirty years, the three-factor model of Fama and French (1993) gained a lot of attention for its ability to capture the relationship risk-return, better than the traditional CAPM, in a sample of U.S. stocks for the period of 1963-1990. The authors showed this relationship by identifying a statistically equal to zero intercept for the regressions with a market-factor (beta) and the proxies for risk factors, size and B/M. Thus, the three-factor model of FF (1993) seemed to explain the cross-section of average stock returns.

Nevertheless, other challenging models, with new significant variables, in different sample data and time frame, have arisen. An example of this is the Carhart (1997) four-factor model, which added momentum to the FF three-factor. Plus, recent studies say that three-factor is incomplete and do not capture all the variation in stock returns, especially variation due to profitability and investment.

In this context, the authors Fama and French proposed a new model –a Five-factor model (FF5F), which included two of the most discussed and empirically tested anomaly-variables mentioned above: investments and profitability. They find that the FF5F is superior to the three-factor model in explaining the cross-section of average stock returns.

For this research we have two main goals: first is to test the performance of the FF5F model, presented in FF (2014), in the Brazilian stock market, and compare their results with ours, thus capturing possible similarities or divergences between the two markets. Then, we intend to make the database of adjusting risk factors available for future research.

Our results showed regression intercepts that were statistically equal to zero. That is important evidence suggesting that nothing is left unexplained in those regressions. As proposed by FF (2014), this is an indication of a good-fit of the model in capturing the variation of returns, thus capturing the risk. For the factors present in the FF three-factor model, we find results that are congruent with previous work done in the local market, reinforcing their validity.

In a broad sense, we seek to contribute to the *academia* in two ways: first, providing a methodological strong replication of FF5F model to serve as a base comparison for future research developments in our local market. Without this base, it is hard to uncover differences. First we need to know how the Brazilian stock market reacts to the models being studied in the American stock market, the most prominent market in the world, and then build upon the realization of divergences. The second contribution is of a practical nature: since the construction of factors is time-consuming and involves heavy programming capabilities, we will have the factors available for future research, thus allowing others to test different samples against our research.

This article is organized as follows: in chapter 2, we present a brief history of asset pricing theory and the main empirical tests which are relevant for this work; next, in chapter 3, we present the methodology, the data and the variables; chapter 4 presents our results; and in chapter 5, we make some closing remarks.

2 Theory

For a long time, the CAPM model has been vastly discussed with both validating and refuting empirical research published about it. Some of the work which found evidence of its validity, with data of its time, were Black, Jensen e Scholes (1972) and Fama and MacBeth (1973). Later on, other empirical work demonstrated the existence of anomaly variables that refute the validity of the beta as the only explaining variable in asset returns.

In this line of work, as mentioned previously, some of the research with most relevancy to our study are: Banz (1981), Fama and French (1992, 1993), Titman, Wei and Xie (2004), and Novy-Marx (2013). Banz (1981) tests the relationship between the size of a firm and its stock returns. The size of the firm, measured by its total market value (price of stock share times the total number the shares outstanding), according to Banz, adds explicative value to the regression done with the CAPM beta. This work demonstrates that small size firms, on average, have higher excess returns than big firms.

Fama and French (1993) introduced the three-factor model using excess market return, size and book-to-market ratio. Given results of FF (1992), which find a strong positive relationship between stock returns and the size effect and the book-to-market ratio (value effect), they build portfolios to capture risk factors related to size and B/M and find that these capture strong variation in stock returns. The stronger relationship captured by their studies is that when the stock betas are not correlated to size, then the relationship of beta and stock returns is stable, reducing the explicative power of beta and emphasizing the size effect, and in the same study they also show that the value effect is still stronger than the size effect (Fama & French, 1992).

Although the FF (1993) three-factor model has been widely accepted, nonetheless many empirical researches have uncovered evidence of abnormal returns in the cross-section of average stock returns. Such examples of these are the two already mentioned capital investments and operating profitability. Titman, Wei and Xie (2004) test the impact of capital investment in average returns. They seek to show if higher investment firms will produce the higher future returns. And their findings indicate that this is not the case. Actually, firms, which increase their capital investment, tend to have negative adjusted future returns, indicating that investors tend to react negatively to the ‘empire building’ attitude.

Another important reference for the FF5F model, is the work of Novy-Marx (2013). In this research, the author investigates the profitability effect, measured by a gross profit to assets ratio, and finds evidence that is opposite to those of previous work of Fama & French, 2006, 2008. The research suggests that profitability has more explanatory power than earnings in predicting the cross-section of returns, and that profitable firms tend to have higher returns than unprofitable firms.

Similarly, many asset-pricing studies have been pursued for the Brazilian stock market, in order to test the validity of CAPM or the three-factor model. Securato and Málaga (2004) study the validity of the Fama and French three factor model in Brazil. The main results indicate that the three factor model is superior to CAPM in explaining stock returns variation also in the Brazilian stock market. Lucena and Pinto (2008), and Chague (2007) also introduce work about the validity of this model and their results corroborate with the previous one. Nevertheless, as we can find in the international environment, researches here also have conflicting results. Rogers and Securato (2009), although their work confirm the predicting power of the three factor model over the CAPM in Brazilian stock market, they capture that the true factors driving explicative power are size and beta.

3 Method

For this initial research into the validity of the FF5F, given our main objective, which is to test the model in the Brazilian stock market, and compare both results, we followed exactly the methodology proposed in FF (2014). Hence, to a sub-set of stock returns of the Brazilian stock market, we created the five risk factors and then regressed a set of size-B/M formed portfolios on the five risk factors.

The five factors are: the already proposed market factor, size effect and value effect, and the new ones, profitability effect (OP), following the work of Novy-Marx (2013), and the investment effect (Inv), following the work of Titman, Wei and Xie (2004). The construction of the variables to represent the profitability effect and the investment effect are respectively:

$$OP = \frac{EBIT}{BookEquity} \quad (1)$$

Where:

OP – represents operating profitability;
EBIT – earnings before interest expense and taxes;
Book Equity – book value of equity.

$$Inv = \frac{(assets_{t-1} - assets_{t-2})}{assets_{t-1}} \quad (2)$$

Where:

Inv – represents the investment opportunities;
$Assets_{t-1}$ – is the total value of assets in year *t-1*;
$Assets_{t-2}$ – is the total value of assets in year *t-2*.

3.1 Sample

The data used are daily stock prices, market capitalization, book value of equity, EBIT, total value of assets and daily returns for SELIC for a group of listed firms at Bolsa de Valores de São Paulo (Bovespa). Data was gathered from both a Bloomberg, L.P. terminal and Economatica. The sample period was January, 2000 through December, 2012.

A Brazilian market peculiarity is that not all Bovespa companies have high liquidity or are easily traded on a daily basis. So, in order to guarantee liquidity of the tested sub-set of firms, we defined the pool of firms as the largest 100 firms in total market value.

3.2 Factors construction

To create the factors, we create a programmable routine to independently order, classify and allocate firms to categories of Size, Value, Operating Profitability (OP) and Investment (Inv). That is, every year, we gather firms with data for that year, classify them from lowest to highest according to the variable of interest (i.e.: size), assign a category (i.e.: small or big), and repeat the procedure for each year in the database. Then, we repeat the procedure for another variable of interest, i.e.: B/M, for the value effect. Now, for each firm-year, we create a grouping that combines the size category with one of the other variables of interest, i.e.: size and B/M.

The size classification divides firms into small and large; the value classification separates them into high and low B/M; the OP division gives us yet another classification into firms of robust and weak operations, the robust ones have the highest profits; and, lastly, the *Inv* classification cuts the sample into firms with conservative and aggressive investment strategies, the conservative ones are those who invest less in asset growth. From this routine, we will end up with firms allocated to portfolios that can be represented by Figure 1 below. The same firm might be part of one, two or three portfolios.

Figure 1 – Groups formed by classifying firms into Size-B/M, Size-O/P and Size-Inv portfolios

		BOOK-TO-MARKET			OPERATING PROFITABILITY			INVESTMENT		
		LOW (L)	NEUTRAL (N)	HIGH (H)	WEAK (W)	NEUTRAL (N)	ROBUST (R)	CONSERV. (C)	NEUTRAL (N)	AGGRESS. (A)
SIZE	SMALL (S)	SL	SN	SH	SW	SN	SR	SC	SN	SA
	BIG (B)	BL	BN	BH	BW	BN	BR	BC	BN	BA

With firms classified independently into portfolios of Size-B/M, Size-OP and Size-Inv, in order to capture the factor loadings, we calculate monthly values for the risk loadings for each one of the portfolios named above in Figure 1. In order to calculate the monthly excess return for each factor, we first create the monthly excess returns for each portfolio, each month. Hence, we use programming routines to sweep the database, gathering firms from each portfolio, each month and calculating the average excess return for that portfolio for that month. At this point, we had over 15,000 firm-month entries to be classified into 27 independent portfolios, and then generate the average portfolio returns for 156 months.

Finally, the last procedure for creation of monthly factor loadings is to create the factors *per se*. The factors are created according to the formulas presented by FF (2014, p. 35) and with these, we are capturing the difference in returns between two risk mimicking portfolios of a given anomaly, i.e.: difference between the excess returns of a portfolio of small firms and a portfolio of big firms. The factors are:

- Small minus Big (SMB)
- High minus Low (HML)
- Robust minus Weak (RMW)
- Conservative minus Aggressive (CMA)

3.3 Time-series regression

With risk factor loadings created, we are left with roughly 156 months of data for each factor. The objective now is to test whether the FF5F model performs better than the FF three-factor model in explaining the cross-section of average returns. To accomplish this purpose, we run a time-series regression of excess returns of six portfolios formed on Size and B/M on the monthly factors, hence the dependent variable is the excess returns for each of the Size-B/M portfolios and the independent variables are the five factors. The model can be represented by the following equation:

$$R_{it} - R_{Ft} = a_i + b_i\left(R_{mt} - R_{Ft}\right) + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t + e_{it} \tag{3}$$

Where:

- R_{it} – is the return on portfolio *i* in month *t*;
- R_{ft} – is the return for the risk free asset in month *t*;
- R_{mt} – is the return on the market portfolio for month *t*;
- a_i – is the intercept for each portfolio *i*;
- SMB – is the risk factor for a small minus big;
- HML – is the risk factor high minus low;
- RMW – is the risk factor robust minus weak;
- CMA – is the risk factor conservative minus aggressive.

Theory tells us that if the five factors capture all the variation in returns, then we should have an intercept that is statistically equal to 0, meaning that there is nothing left to explain.

4 Results

4.1 Factors

In order to better understand whether the FF5F model may explain average returns, the first step is to examine the patterns in average returns that the model seek to explain. We will examine value-weighted (VW) portfolios independently formed on sorts of size, B/M, profitability (OP) and investment (Inv) by procedures explained on item 3.2 above. Table 1 presents the average monthly excess returns for all the portfolios.

In panel A, we can see the patterns resultant for portfolios formed on size and value. We can see that two out of three portfolios of small firms have higher average returns (in excess of the risk-free asset) than those portfolios of big firms, with statistical significance at 0.01%. This reinforces previous empirical evidence that small firms should have higher excess returns to compensate investors for risk. This is also the pattern found in studies of the U.S. market.

On the other hand, we will find that expected excess returns reduce with firms increasing B/M. Although, this is the opposite of the pattern found in the U.S. market, this pattern is consistent for both small and big firms and all but one of the portfolio returns have statistical significance. We believe that this may make sense, since we view the B/M as the view that the market has of the firm, and a high B/M means the market has a negative view of the firm, hence the lower returns for high B/M firms, both small and big.

Table 1 – Average monthly excess returns for portfolios formed on *Size* and *B/M*, *Size* and *OP*, and *Size* and *Inv*; January 2000 to December, 2012; 156 months

At the end of each year, stocks are independently allocated, independently, to two Size groups (Small or Big) using the median market cap, and to three B/M groups (Low, Medium and High) using tercile. This procedure produces 6 value-weighted (VW) Size-B/M portfolios. The Size-OP and Size-Inv portfolios are formed in the same manner. Operating profitability (OP) is measured with earnings before interest and tax (EBIT) for fiscal year ending in year t-1 divided by book equity. Investment (Inv) is the change in total assets from the fiscal year ending in year t-2 to the fiscal year ending in t-1, divided by total assets in t-1. This table shows averages of monthly excess returns using the Selic rate for one month as the risk-free asset. (*p<0.05, **p<0.01, ***p<0.001)

	LOW	Medium	HIGH
Panel A: Size-B/M portfolios			
Small	0.024***	0.014***	0.003
test t	(3.27)	(3.18)	(0.76)
Avg # of firms	16	20	26
# of observations	1,026	1,530	2,289
Big	0.015***	0.007***	-0.008**
test t	(6.45)	(2.64)	(-2.42)
Avg # of firms	21	18	13
# of observations	2,217	1,635	1,134
Panel B: Size-OP portfolios			
Small	0.012**	0.011***	0.014**
test t	(1.96)	(2.92)	(2.07)
Avg # of firms	23	26	19
# of observations	1,569	1,545	1,341
Big	-0.004	0.008***	0.016***
test t	(-1.21)	(2.65)	(6.24)
Avg # of firms	18	23	20
# of observations	1,299	1,389	1,743
Panel C: Size-Inv portfolios			
Small	0.013**	0.013**	0.013**
test t	(2.54)	(2.14)	(2.05)
Avg # of firms	22	20	22
# of observations	1,643	1,458	1,467
Big	0.010***	0.005*	0.011***
test t	(3.67)	(1.95)	(3.60)
Avg # of firms	18	22	19
# of observations	1,422	1,720	1,568

Panel B shows the patterns resultant for portfolios formed on size and OP. The size effect persists for two out of three sorts on profitability. The sort for the highest OP group does not show the size effect, with returns for big firms being higher for this group. Looking at the return patterns from lower to higher profitability groups, we see a clear increasing pattern. This evidence makes logical sense, hence firms with highest operating profitability will be seeing by investors as companies to invest on, papers with higher demand, and therefore show higher returns. Possibly, the size effect is overtaken by the profitability effect in Big-High companies, that is, for big firms with high OP it might be that the profitability effect has a greater impact on returns in the view of Brazilian investors of stock markets, given that these investors tend to be conservative. These results were consistent to those seem on U.S. market data.

Finally, on panel C, we present results for sorts on Size-Inv portfolios. This is a real conundrum, given that, despite the fact that all six portfolios have statistical significance, there are no clear patterns. For small firms, across investment groups the expected returns remain the same. And for big firms, again the pattern is not clear. This might signal a problem of labor-intensive x capital-intensive operations. There might be a difference between the two markets in question, where here we might have firms that are more labor intensive, given the lower cost of labor, than firms in developed countries. Then, to test the returns in terms of capital investment might not be the best solution to this market, hence capex investment, high or low, would not be either way definitive for generating returns. This question poses the need for future investigation.

The next step is to analyze the risk factor loadings. In Table 2, we present summary statistics for monthly factor returns. We created 2x3 portfolios formed on Size and B/M, OP and Inv. And the SMB factor is the average of all factor loadings. $R_m - R_f$ is the market factor, and it is the VW excess returns on the market portfolio of all sample stocks on the Selic rate for one-month.

The averages for the monthly factors are in percentage points and were relatively similar to the American market results. Interesting also to mention that the standard deviations were not very high showing lower variability than expected. But as we can see, we do not have statistical significance to any of the factors, being that these are statistically equal to zero.

Table 2 – Summary statistics for monthly factor returns; January 2000 to December, 2012; 156 months

The market factor is $R_m - R_f$ and it is the value-weighted (VW) monthly return on the market portfolio of all sample stocks minus the Selic rate for one month. For remaining factors, at the end of each year, stocks are independently assigned to two Size groups, using the mean market cap as breakpoint, to three book-to-market equity (B/M), operating profitability (OP), and investment (Inv) groups, using terciles. The sorts on B/M yields the HML factor, which uses the VW portfolios, formed from the intersection of the Size and B/M sorts (2x3 = 6 portfolios). Similarly, the profitability and investment factors, RMW and CMA, uses VW portfolios from the intersection of Size and OP or Inv sorts. (*p<0.05, **p<0.01, ***p<0.001)

	Rm-Rf	**SMB**	**HML**	**RMW**	**CMA**
Mean	0.86	0.05	-0.05	0.18	0.01
Std Dev	6.50	0.50	0.62	1.49	0.38
t-statistic	(1.649)	(1.076)	(-1.009)	(1.484)	(0.212)
Observations	156	142	156	153	145

Although, the lack of statistical significance may reduce the importance of the factors in the Brazilian market, previous works like Securato and Málaga (2004) have presented similar results when testing the FF three-factor model in this market. However, as it was the case with the work cited, our work also found statistical significance when testing the monthly factors in the time series regressions. Let's see these results next.

4.2 Regressions

Once the monthly factors are constructed, they are now available to test whether these mimicking risk factors may capture all the variation in the cross section of expected returns. If they do, we expect to see an intercept, from equation (1) above, that is statistically equal to zero, suggesting that these factors proxy for all risk factors (Fama & French, 2014).

We present on Table 3 the results from regressing monthly excess returns from six portfolios formed on Size and B/M on the monthly factors: excess market return, SMB, HML, RMW, CMA. The table shows intercept and coefficients for each of the factors and t-statistics for these. The results are promising, given that four out of six portfolios have intercepts statistically equal to zero and the other two, although significant, are very small. These results suggest that the five factors are capturing all, or most, of the variation from the cross-section returns. The intercepts for portfolios SL, SM, BL, BH are equal to zero. That is nothing is left unexplained in the regression. The intercepts for portfolios SH and BM are statistically different from zero, but these are in magnitude of less than 0.1% per month.

Overall in the regression, market factor, SMB, and HML seem to have strength in capturing variation in most of the portfolios. Factors RMW and CMA have less explanatory power. For the market factor, coefficient *b* is statistically significant ($p < 0.1\%$) for all portfolios, showing signs of variation that is linked to the market risk (traditional beta). We observe a tendency for the small firms to reduce market coefficient from low to high B/M firms, consistently with the pattern shown above (Table 1).

Then, for the risk factor SMB, factor with intends to capture the variation between portfolios of small firms and those of big firms, again we have evidence of strong explanatory power. For four out of six portfolios, we find p-values of less than 0.1%. These portfolios are SL, SM, SH, and BL. Again, we see a pattern of decreasing coefficient for small firms going from low to high B/M firms. Interesting to notice that for big firms with low B/M, the coefficient is negative and significant.

Table 3 – Regressions for 6 Size-B/M portfolios; January 2000 to December 2012; 156 months
Each year, we allocate stocks to two Size groups (Small and Big) and, independently, we also allocate to two B/M groups (Low, Medium and High), using terciles. The intersections of these two sorts produce six Size-B/M portfolios. The dependent variables for each of the six regressions are the monthly excess returns on these six Size-B/M portfolios. The independent variables are the excess market return, the Size factor, SMB, the value factor, HML, the profitability factor, RMW, and the investment factor, CMA. We show below the FF5F intercept and slopes, and their t-statistics. (*p<0.05, **p<0.01, ***p<0.001)

B/M	Low	Med	High
		a	
Small	-0.0002	0.0004	-0.0004*
	(-0.391)	(1.619)	(-1.811)
Big	0.0002	-0.0004**	0.0004
	(1.333)	(-2.041)	(1.068)
		b	
Small	0.0946***	0.0557***	0.0387***
	(12.367)	(12.384)	(11.226)
Big	0.0479***	0.0695***	0.0563***
	(19.306)	(21.503)	(9.315)
		s	
Small	0.7814***	0.5229***	0.4845***
	(7.437)	(8.472)	(10.236)
Big	-0.1017***	-0.0073	-0.0314
	(-2.988)	(-0.165)	(-0.379)
		h	
Small	-0.3388***	0.1043*	0.2636***
	(-3.685)	(1.931)	(6.365)
Big	-0.1524***	-0.0551	1.4089***
	(-5.113)	(-1.421)	(19.398)
		r	
Small	-0.0851***	-0.0316*	0.0010
	(-2.643)	(-1.672)	(0.070)
Big	0.0156	-0.0116	-0.0474*
	(1.493)	(-0.855)	(-1.862)
		c	
Small	-0.1377	-0.0772	0.0081
	(-1.190)	(-1.136)	(0.155)
Big	-0.0312	-0.0390	-0.1207
	(-0.834)	(-0.799)	(-1.321)

The HML factor also shows strong explanatory factor, now for five out of six portfolios. The only portfolio with no statistical significance is the one formed by big-medium firms. The others show strong predictive power and congruent with previous studies suggests presence of a risk factor related to the B/M. It is interesting to notice that both, small and big, low B/M portfolios present a negative coefficient, suggesting an indirect relationship between this factor and average returns. This means that portfolios of low B/M tend to produce higher returns and not the opposite, which FF (2014) evidence suggests. Although, different from American markets evidence, this is consistent with what we found in Table 1, where we see low B/M firms present lower average returns than high B/M firms.

The new factor RMW, the factor that seeks to capture the profitability effect, or the variation in returns between firms with robust and weak results, shows a timid explanatory power. We find statistical significance in three out of six portfolios with p-values varying from 0.1% to 5%. Although less striking, this is a good initial result for the validation of the profitability effect in the Brazilian market. Again, the small firms show a pattern of reducing coefficients from low B/M firms to high B/M firms. Another interesting evidence is that all three significant coefficients are also negative, again suggesting an indirect relationship between this factor and average returns for these portfolios. This negative relationship contradicts evidence uncovered and shown in Table 1, which suggested increasing returns with increasing OP. Since this result cannot be easily explained within the economic theory, we believe there is need for further investigation on this factor.

The final factor, CMA, it is also a new factor added to the model. None of the six portfolios formed on size and B/M show statistical significance on this factor. This suggests no explanatory power for the investment effect proposed by Titman, Wei & Xie (2004) and FF (2014). Similarly, with the RMW factor, we believe we need further investigation for the CMA factor, given that our results are very different form those with American markets data.

5 Conclusion

In this research, we proposed to replicate the brand new Five-Factor model of Fama and French (2014) with Brazilian stock market data from January 2000 through December 2012. The gain from replicating this work is to create a base of reference for future work, which may advance in creating or proposing new factors that may be more relevant in our market. Without this base of reference, it would be harder to promote or refute the validity of factors, which are being studied in other markets.

Our main goals are to create this base of reference for further studies and to offer a database of FF5F model factors for researchers that wish to advance on this field. We believe these goals were accomplished since we did a full replication of the original FF5F model, with very minor adaptation, only those that were extremely necessary to adequate to our market and availability of data.

Overall in the time-series regressions, market factor, SMB, and HML seem to capture most of the variation in average returns. For these three factors, the same used in the FF three-factor model, we have strong evidence of their predictive power congruent with previous studies such as Securato & Málaga (2004).

The new factors, RMW and CMA, have shown less explanatory power in this dataset, and, have been less studied in the Brazilian market. We believe that this research does not fully explain these factors and further investigation of these factors are warranted.

Mostly important, the intercepts for four out of six portfolios were statistically equal to zero. That is important evidence suggesting that nothing is left unexplained in those regressions. Furthermore, the intercepts for the two remaining portfolios were very small and in magnitude of less than 0.1% per month. This evidence is one of importance, since following the proposition of FF (2014), this represents that the model is capturing almost all the variation in the cross-section of average returns.

Furthermore, for future work, we propose that other tests of the FF5F be done trying different measures and variables. For instance: for investment, one could use investment in capex instead of total assets, as proposed by Titman, Wei and Xie (2004), and, for operating profitability, one could use EBITDA, which is frequently used in Brazilian market for valuation purposes. Another measure worth revisions is the use of Selic as the risk-free rate. The Brazilian government bonds rate is historically high and varying a lot from the early 2000s to now, therefore, proposing a new form of measurement for the risk-free rate is also warranted.

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