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Conditional CAPM using Expected Returns of Brazilian Market from 1992 to 2013: a New Approach

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Abstract- In the last decades, CAPM model has been of great interest in the scientific scene. Despite all the criticism, the improvement of the static CAPM, which has generated new dynamic models, provided investors with stronger guarantee through financial transactions. The CAPM and its static version were and are still very important in the financial scene. Nowadays, more sophisticated adaptations of the CAPM are found, which allow us to explain some matters in finance that had remained unqualified for a couple of time. Considering such discussion about the CAPM validity, this study aims to create a basis for reflection upon the conditional model, comparing it with the static one. In order to verify such facts, tests of conditional models are examined (with beta varying throughout the exercise), something uncommonly studied in the literature. Such tests are suitable to incorporate variances and covariance that change at long run. Methodological wise, the study tested the conditional CAPM model borrowing a leaf from Jagannathan and Wang (1996) using macroeconomics and financial variables from the Brazilian New Market. Based on our findings, there is evidence that the conditional CAPM of Jagannathan and Wang (1996) for the North American market is perfectly applicable to the Brazilian New Market.

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Abstract- In the last decades, CAPM model has been of great interest in the scientific scene. Despite all the criticism, the improvement of the static CAPM, which has generated new dynamic models, provided investors with stronger guarantee through financial transactions. The CAPM and its static version were and are still very important in the financial scene. Nowadays, more sophisticated adaptations of the CAPM are found, which allow us to explain some matters in finance that had remained unqualified for a couple of time. Considering such discussion about the CAPM validity, this study aims to create a basis for reflection upon the conditional model, comparing it with the static one. In order to verify such facts, tests of conditional models are examined (with beta varying throughout the exercise), something uncommonly studied in the literature. Such tests are suitable to incorporate variances and covariance that change at long run. Methodological wise, the study tested the conditional CAPM model borrowing a leaf from Jagannathan and Wang (1996) using macroeconomics and financial variables from the Brazilian New Market. Based on our findings, there is evidence that the conditional CAPM of Jagannathan and Wang (1996) for the North American market is perfectly applicable to the Brazilian New Market.

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1. INTRODUCTION

The last two decades witnessed a growth in numbers of empirical studies that examined the product capacity of the static version of Capital Asset Pricing Models (CAPM). Conclusions from these studies demonstrated that static CAPM was unable to give a reasonable explanation to *cross-sectional* variation of the average returns of the analyzed portfolios.

Costa Jr. (1996) Emphasized this idea when he mentioned that an original version of CAPM of absolute simplicity, recognized information of a greater relevance and applied it in a comprehensible manner. What happens is that the hypothesis that surrounds this original version requires a market of a perfect competition, which makes one to fear for lack of realism. Answers to this skepticism could be found in the empirical test done in the current study, that is, what is important is not the realism of the hypothesis of startup, but, to know if it is capable of concluding for the adjustment of the models to reality.

Fama and French (1992) the ferrous critics of CAPM performed multivariate tests (multiple regression) and found two variables that explain the greater part of *cross-section* variation of medium returns: Book Value/Market Value index have a positive correlation with the returns of stocks while the variable as a whole is negative and significantly correlated and the beta appeared insignificant in this test.

Fama and French (1993) found in their model three statistically associated factors that are significant as different from zero. This result suggests that the *proxy* of the factors associate's risks to returns of the human capital and the betas are unstable. Notwithstanding, this model was able to explain the *cross-sectional* of the expected returns.

The CAPM and its static version were and are of great importance in finance. Therefore, in today's applications we find complex adaptations of CAPM that enables one to envisage results for questions that are yet to be resolved in finance.

Based on this panorama therefore, and considering the whole scope of discussion that surrounds the validity of CAPM, this study aims to present the advantages of the conditional or dynamic model (models that incorporate variances and co-variances that changes during a space of time), in relation to a static model.

Therefore, we study the tests of conditional models (*beta* variance during a period) that are not commonly studied in literature. These tests are convenient in order to incorporate variances and co-variances and changes in a future period. In the conditional model test, we highlight the studies of Jagannathan and Wang (1996), and Ferson and Harvey (1999).

Bonomo (2002) mentioned yet, important studies about conditional CAPM among these, we cite Bodurtha and Mark (1991) where a *beta* of a group of assets is defined as a conditional covariance of error committed upon forecast of the returns on assets and the error on forecasted market returns. These models have various beta coefficients while the standard CAPM has only one.

Finally, this study is structured in five sections, firstly, being contemplation of introductory aspects of the study; the second section has the background of

Conditional Capital Asset Pricing Model, thirdly, about the methodological approach of Fama and MacBeth (1974).

II. BACKGROUND OF CONDITIONAL CAPITAL ASSET PRICING MODEL

CAPM is defined as a model which relates an expected profitability of an asset in a certain market and equilibrium with its undiversified risks, also known as *beta*. Besides Sharpe, other authors also formulate CAPM, in its static version. Among these authors are Lintner (1965), Mossin (1966) and Treynor. This version of static CAPM or conditional has some consistent results when we perform empirical tests in order to verify the adherence capacity of the model to the reality of some economies.

In all tests of non-conditional CAPM such as that of Fama and MacBeth (1974), Black, Jensen and Scholes (1972) it was supposed that *beta* would be static, that is, the assets systematic risk would not change.

Haugen (1986) shows that Black, Jensen and Scholes consider that there is a positive linear relationship between *beta* and the expected return. As a consequence of this fact, Black, Jensen and Scholes (1972) encounter in their test of CAPM a positive relationship between profitability and the *beta*.

Merton (1973) shows that the Consumption Capital Asset Pricing Model (ICAPM) had as an objective, generalize the CAPM model of Sharpe (1964) for an intertemporal context. The original ICAPM takes the hypothesis that the investors consumed all the reaches after a period, such that the said reaches and the consumptions are confused.

The static CAPM of Sharpe- Lintner-Black, given as R_i , which denotes the returns on, shares i and R_m the portfolio market returns for all shares of the economy. The version of Black (1972) is:

$$E[R_i] = \gamma_0 + \gamma_1 \beta_i \quad (2.1)$$

where γ_0 and γ_1 are defined as expected market returns and risk Premium expected from the market respectively, and where β_i is defined as:

$$\beta_i = \text{Cov}(R_i, R_m) / \text{Var}[R_m] \quad (2.2)$$

Fama and French (1992) followed Black (1972) and examined empirically the static CAPM, arriving at a conclusion that, there is a weak relationship between medium return and the *beta*, and finding a strong evidence against static CAPM.

Thus, Jagannathan and Wang (1996) developed a study which partially contradicts these evidences. In these same studies they observed that,

upon application of CRSP index as a base for market portfolio, they found in their non-conditional model, implicit in the conditional CAPM, an explanation close to 30% of *cross-sectional variation of the medium returns of 100 market portfolios*, similar to that used by Fama and French (1992). For the implementation of CAPM therefore, is commonly used as *proxy* all the shares that are enlisted in the *New York Stock Exchange (NYSE)* and the *American Stock Exchange (AMEX)*, which could be considered as a reasonable *proxy* for the market returns on portfolio of all assets. However, Fama and French (1992) found that, upon usage of that *proxy*, the same was not sufficient for a satisfactory analysis of the performance of CAPM.

As a result of this fact and in order to ameliorate the *proxy*, Jagannathan and Wang (1996) followed Mayers (1972) and included in their models returns on human capital. When human capital is also included in the portfolio of the market, the non-conditional model implicit in conditional CAPM conditional is then capable of explaining more than 50% of the *cross-sectional variation of the medium return*. Besides this, the statistics tests where unable to give answers as they reject the model.

III. METHODOLOGY OF FAMA AND MACBETH (1974)

Haugen (1986) shows that Fama and MacBeth (1974) methodology introduced a significant difference as related to the former tests, since they arrived at coherent results concerning fundamental forecasts of CAPM (Black, 1973 version).

Fama and MacBeth (1974) constituted 20 portfolios which contain shares enlisted in NYSE for the period of 1926 through 1929. Latter, they estimated the *beta* of each of the portfolios and highlighting the monthly returns of the market index for the period of 1930 through 1934. They used the *betas* of each of the portfolios of the prior periods to forecast the monthly returns of the portfolios for the periods subsequent to 1935 through 1938. The process estimating the market *beta* was repeated nine times until 360 estimations were ascertained which was in the January 1935 through June of 1968.

Haugen (1986) showed that in this case, Fama and MacBeth adopted *betas* and returns from different periods. The estimated *beta* in a period is used to estimate interest rate of returns for a future period. The results of these tests were very comforting, in that, CAPM gained the supports of scientists after the publication of this study.

Even though the critics of the model are yet to find in various studies that takes it as literary support, amongst these, one would observe the model produced by Jagannathan and Wang (1996) through Fama and MacBeth (1974) that utilizes the same methodology.

IV. THE CONDITIONAL CAPM MODEL FOR BRAZIL USING RETURNS OF BRAZILIAN MARKET

The selected variables (in the first place) are consisted of integral part of the Conditional CAPM Model for Brazil. It refers to the portfolios constructed through the monthly share returns negotiated at the Stock Market of São Paulo (Ibovespa), GDP of the market and, for the premium, the spread between Interfinances Operation Deposit Index (DI), reported by the Central of Custody and Liquidation of Private Sector Papers (CETIP) and the interest rate (Selic), that is aimed to serve as a forecast for the variations of the business cycle.

Using the approach cited above, seven portfolios were created for the Brazilian market, containing five shares of Ibovespa during the period of jan/1992 through dec/2013.

The data were collected from the Central Bank of Brazil, and the Economática databases.

Following the steps above, Jagannathan and Wang (1996), used the returns of all the shares of NYSE and AMEX and constituted 100 portfolios in function of size variable with monthly returns from July of 1963 to December of 1990, summing 330 observations. For each portfolio one calculates a regression between shares that compose the portfolio and the market indexes (NYSE and AMEX).

We created a time series of the monthly returns for each of the seven portfolios (Brazil). The model for the moment is estimated using the method of generalized moment.

Also, we used the average value of each of the coefficients to determine their significance, and thus, the portfolios were gradually re-balanced annually.

According to Fama and MacBeth (1974) these portfolios were rebalanced period by period, before the estimation of the beta attains the total of the estimation of the analyzed period. All the shares were attributed the same weight in each portfolio.

An observation that confronts the literature review with the research deals with the prior decision as to selection of the Brazilian index, as gearing the regional markets of the region. This implies an implicitly assumption that the market is segmented.

V. ANALYSIS OF RESULTS BASED ON BRAZILIAN IBOVESPA

The regressions of the models are estimated using Fama & MacBeth (1974) methodology. The model was estimated using the generalized model of the moments. Through the correction of the errors we verified that if the residual variance has an effect on the price of the assets or the expected rate of returns and, base on the results, there is no indication that the assets with residual variance greater than the average, produces rate of return higher than the weighted average during the future period. Seven portfolios were constructed with five shares in each one. The tested period ranged from january, 1992 through december 2013. For the Brazilian market the premium is represented by *spread* between the interest rate of CETIP and that of SELIC. While in the human capital it is represented by the market Gross Domestic Product (GDP), the market *proxy* will be Ibovespa. Thus, the equation that is being estimated for the Brazilian market would be as follows:

Table 5.1 : Static CAPM without Human Capital (Brazil)

$$E[R_{it}] = c_0 + c_{size} \log(ME_i) + c_{ibov} \beta + c_{premio} \beta + c_{pib.mer} \beta$$

Coefficients:	C ₀	C _{ibov}	C _{premio}	C _{pib mer}	C _{size}	R-square
Estimate:	-2,47	1,30				8,50
t-value:	-0,93	0,33				
p-value:	0,00	0,00				
Correction -t:	-0,28	0,09				
Correction- p:	0,00	0,00				
Estimate:	-0,74	0,64			0,75	45,00
t-value:	-0,46	0,16			4,80	
p-value:	0,00	0,00			0,00	
Correction -t:	-0,35	0,67			2,66	
Correction -p:	0,00	0,00			0,00	

Results available in tables 5.1, above show that *t value* for C_{ibov} is 0,33. The R² of the regression is only 8,50%. This means to say that the *cross-sectional* variance of the average returns is yet to be fully applied when we use a static CAPM without the inclusion of the market GDP in the case of Brazil.

The model for the correction of errors as per estimation, is not significant. Thus, after correction of errors, that treat the error of the model so that one would use this term to reflect on the behavior of the variables in short run with its value a long run, that is, it is a means of reconciliation of the behavior in a short run of a variable

with its behavior for a future period. The C_{ibov} is not significantly different from zero. When the size variable is introduced into the model, we found for C_{size} a t -value of 4,80 and the R^2 rose to 45,00%.

Notwithstanding the increase of R^2 and the fact that the model did not present any significant changes after the correction of the errors, the model appears inconsistent (because even after inclusion of the size variable, for the Brazilian market, it does appears to not have been influenced as a result of the static model not absorb the effects of this variable). Analysis of the Brazilian market appears to be in the same direction as conclusions reached for the, the North American market.

The regressions of the models are estimated using Fama & MacBeth (1974) methodology. The model was estimated using the generalized model of

the moments. Through the correction of the errors we verified the if the residual variance has an effect on the price of the assets or the expected rate of returns and, base on the results, there is no indication that the assets with residual variance greater than the average, produces rate of return higher than the weighted average during the future period. Seven portfolios were constructed with five shares in each one. The tested period ranged from january, 1992 through December 2013. For the Brazilian market the premium is represented by *spread* between CETIP and SELIC interests' rates, while the human capital is represented by the *GDP* on the nation. The *proxy* of the market would be Ibovespa. The equation that is being estimated for the Brazilian market is as follows:

Table 5.2 : Static Capm with Human Capital (Brazil)

$$E[R_{it}] = c_0 + c_{size} \log(ME_i) + c_{ibov} \beta + c_{premio} \beta + c_{pib.mer} \beta$$

Coeficientes:	C_0	C_{ibov}	C_{premio}	$C_{pib.mer}$	C_{size}	R-square
Estimate:	-2,10	-1,19	-3,74			11,20
t-value:	-0,99	-0,15	-0,80			
p-value:	0,00	0,00	0,00			
Correção -t:	-0,34	-0,22	-0,35			
Correção -p:	0,00	0,01	0,00			
Estimate:	-0,79	0,66	0,43		0,61	41,00
t-value:	-0,30	0,12	0,33		3,90	
p-value:	0,00	0,18	0,32		0,00	
Correção-t:	-0,24	0,03	0,26		2,50	
Correção-p:	0,00	0,06	0,45		0,00	

Results in table 5.2 above show that the estimated value for C_{premio} is not significantly different from zero. The t -value for C_{premio} is -0,80. The R^2 is only 11,20%. Note that the R^2 is similar to the result encountered in the previous model.

When the model for the correction of errors is introduced the t -value for C_{premio} becomes -0,45. When the variable size is added to the model the t -value for C_{size} comes to 3,90. And when one introduce the model for correction of errors, the t -value for C_{size} declines to 2,50 and R^2 grows to 41,00%.

The value of R^2 for the Brazilian market remained 41,00% (a value close to that found in the static CAPM) and the estimated value for C_{premio} , and after the correction of the errors, it became significantly different from zero. This fact could be explained by non-inclusion of market GDP. In this regards, the conditional model appears to be more effective for the explanation of the *cross-sectional* variances average of the market returns for Brazilian market.

The regressions of the models are estimated using Fama & MacBeth (1974) methodology. The model was estimated using the generalized model of the moments. Through the correction of the errors we verified the if the residual variance has an effect on the

price of the assets or the expected rate of returns and, base on the results, there is no indication that the assets with residual variance greater than the average, produces rate of return higher than the weighted average during the future period. Seven portfolios were constructed with five shares in each one. The tested period ranged from january, 1992 through december 2013. For the Brazilian market the Premium is represented by *spread* between the CETIP and SELIC interest rates, while the human capital is represented by the GDP of the Brazilian market. The market *proxy* would be Ibovespa. The equation that is being estimated for the market is as follows:

Table 5.3 : Conditional CAPM with Human Capital (Brasil)

$$E[R_{it}] = c_0 + c_{size} \log(ME_i) + c_{ibov} \beta + c_{premio} \beta + c_{pib.mer} \beta$$

Coefficientes:	C ₀	C _{ibov}	C _{premio}	C _{pib.mer}	C _{size}	R-square
Estimate:	-1,01	2,65	2,60	-0,59		13,00
t-value:	-0,95	0,25	-0,28	-0,51		
p-value:	0,00	0,00	0,00	0,00		
Correção -t:	-0,28	0,12	-0,19	-0,03		
Correção-p:	0,00	0,03	0,18	0,12		
Estimate:	-0,66	10,75	1,86	-1,28	0,71	53,00
t-value:	-0,34	0,31	0,18	-0,43	4,10	
p-value:	0,00	0,00	0,00	0,00	0,00	
Correção-t:	-0,11	0,02	0,10	-0,23	0,31	
Correção-p:	0,23	0,12	0,56	0,01	0,00	

Results showed by table 5.3 above show that the estimated value for C_{pib.mer} using Fama-MacBeth methodology, is not significantly different from zero. The *t-value* is -0,51 and R² is 13,00%.

While in the Brazilian market, when one introduces a model for the correction of the errors *t-value* for C_{pib.mer} drops to -0,23, the *p-value* goes to 0,31 and the coefficient C_{premio} becomes significant. When the

size is added to the model, the *t-value* for C_{size} becomes 4,10, and o R² rises to 53,00%.

The conditional CAPM with the inclusion of GDP of the Brazilian market appears to be closer in results at to that of the United States. Besides that the C_{premio} and C_{pib.mer} variables have become significantly different from zero after the correction of the errors, the consistence of the model does not seem to have been touched.

Table 5.4 : Conditional CAPM without Human Capital (Brazil)

$$E[R_{it}] = c_0 + c_{size} \log(ME_i) + c_{ibov} \beta + c_{premio} \beta + c_{pib.mer} \beta$$

Coefficientes:	C ₀	C _{ibov}	C _{premio}	C _{pib.mer}	C _{size}	R-square
Estimate:	-1,43	3,97		-0,52		11,00
t-value:	-0,89	0,80		-0,55		
p-value:	0,00	0,00		0,00		
Correção-t:	-0,19	0,13		-0,03		
Correção-p:	0,00	0,01		0,04		
Estimate:	-0,95	1,58		-1,35	0,78	52,00
t-value:	-0,46	0,70		-0,66	3,80	
p-value:	0,00	0,00		0,00	0,00	
Correção-t:	-0,12	0,02		-0,13	0,38	
Correção-p:	0,02	0,03		0,15	0,00	

Results found in tables 5.4 above show that the estimated value of C_{pib.mer} using Fama-MacBeth methodology is not significantly different from zero. The *t-value* is -0,55 and R² is only 11,00%. However, after the correction of the errors, we conclude that C_{pib.mer} becomes significantly different from zero as against the North American market.

When we introduce the size variable, the *t-value* becomes 3,80 and R² grows to 52,00%. Besides the rise of R² the model is not consistent. It is necessary to permit that beta varies at long run so that the expected cross-sectional returns of the market would be explained.

VI. FINAL COMMENTS

The static CAPM, without the inclusion of the human capital variable does not appear to satisfactorily explain the expected cross-sectional returns of the analyzed markets.

After inclusion of variable "size", the R² of all the models had an abrupt change. And besides this fact that the finding are being coherent with what is found in literature, we conclude that the models for the analyzed countries appears inconsistent for they did not present any changes in the parameters at long run.

The model did not appear to present satisfactorily the reality of the various economies. Firstly, because we know that business cycle is dynamic in most economy and as per models analyzed above this variable was not contemplated and secondly, because the market proxy would not just be enough to represent any economy.

The model needs to be ameliorated with the inclusion of new variables that better represent each market.

Therefore, we must not discard static CAPM, because it is capable of explaining the market for a determined space of time.

As different from the North American market, the Brazilian market have an increasing relations between the average returns of the portfolios and the size, thereby showing a substantially high returns for a bigger sized portfolio.

In relation to the conditional CAPM, without the inclusion of human capital variable we observed in the Brazilian case, the estimated value of C_{premiu} is not significantly different than zero for the new market shares

However, when we introduce the model for the correction of errors variable C_{premiu} becomes significantly different from zero for the case of Brazil. In case of North America and even after adoption of the model for the correction of errors, the variable C_{premiu} continue to be significantly different from zero. This signifies that the risk premium drastically influenced the market analyzed. When the size variable is incremented to the model the R^2 rises proportionately for the Brazilian.

When the size variable is added to the model the R^2 suffers a considerable increase, even though the variable size presents some effects on the model. This means that the conditional CAPM, even without the inclusion of human capital, is able to explain the efficacy of the *cross-sectional* variance medium returns of the analyzed portfolios. This happens in that the size variable or size effect aggregately influenced the Brazilian Market.

In relation to the conditional model using New Market Ibovespa Portfolio we may conclude with no doubt that the power of explanation of the model increases reasonably for each one of the cases analyzed.

The model appears to be able to capture the effects of the dynamics of the economy. By introducing the size variable, the models have a considerable increase in their R^2 , but note that this variable appear to be more significant in the Brazilian market as probably as a result of differences found in the composition of new market shares of these market.

Finally, there is evidence that the conditional CAPM of Jagannathan and Wang (1996) for the North American market is perfectly applicable to the Brazilian new market , Our finding in this study permits us to differentiate and also identify an important tool for the potential investor of these countries.

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