TESTING THE CONDITIONAL CAPM WITH THE INCLUSION OF HUMAN CAPITAL

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ABSTRACT

Asset pricing models, such as the Capital Asset Pricing Model (CAPM), are still widely discussed in the finance area, including the scientific community as well. These models are used theoretically and practically in the area of investments and financial markets to predict the risk and return of securities and portfolios, as well as in corporate finance, to analyze the viability of investments. For the application of this model in the Brazilian market, 40 stocks with the highest liquidity index of the Brazilian market were selected, divided into 5 (five) portfolios, each portfolio containing 8 shares, during the period from 2008 to 2016. The results show the R2 value of 48% is very close to that found in the static CAPM of 43% and the estimated value for the variable Cpib.mer, after correcting the errors, became significantly different from zero, facts that can be explained by the non-inclusion of market GDP. Thus, the conditional model seems to be more effective in explaining the average cross-sectional variation of returns in the Brazilian market than the non-conditional CAPM, consistent with the tests performed by Jagannathan and Wang model for the American market. The results obtained by these authors, considering the conditional CAPM without Human Capital, the t-value for Cibov is 3.28 and the R2 of the regression is 29.32%. When the size variable is introduced in the model, the values change, being for Csize a t-value of -1.93 and for R2 of 61.66%.

Keywords: Financial Market, Conditional CAPM, Stock Market, Portfolio, Capital Human.

JEL: G11, G14, G15.

INTRODUCTION

The search problem of this study aims at to a better adjustment of the CAPM model, using the conditional CAPM model developed by Jagannathan & Wang (1996), which is based on the variability of risk and risk premium, which is applied to the São Paulo stock exchange, Brazil 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 (Bovespa), GDP of the market and, for the premium, the spread between Inter- finances 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.

The mentioned model was estimated using the generalized method of moments, as described in the research methodology. Subsequently, by correcting the errors, it is verified that the residual variance affects the price of the assets or the expected rate of return. As described above, five portfolios were built with eight shares in each one, and these, with greater liquidity in the Brazilian stock market, were selected as defined in the methodology. The tested period is from January 1, 2008 to December 31, 2016. The premium is represented by the spread between the CETIP rate and the SELIC rate. Human capital, on the other hand, is represented by the market GDP, when applied. The market proxy will be the IBOVESPA.

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LITERATURE REVIEW

Following the steps of Jagannathan and Wang we created a time series of the monthly returns for each of the five portfolios (Brazil). The model for the moment is estimated using the method of generalized moment. Jagannathan and Wang model observed in their tests that, when using the CRSP index of the Center for Research in Security Prices as market portfolios, they found in the non-conditional model, implicit in the conditional CAPM, an approximate explanation of 30% of the cross-sectional variation. Sectional of the average return of 100 market portfolios, similarly to the study by (Fama & French, 1992).

Beta is given by the ratio between the covariance of the return on the firm's stock and that of the market portfolio, by the variance of the return on the market portfolio. It corresponds to the angular coefficient of the CAPM's simple regression line, which is calculated through the return on the company's share in relation to the return on the market portfolio. Knowing that the relationship between asset risk and required return is linear, and if beta is the appropriate risk metric, then, the greater the risk the asset presents, proportionally, the greater the return desired by the investor.

Another important line that we follow states that the linear relationship between the expected return and the beta stems from the efficiency of the market portfolio, therefore they are not independently testable. In any sampling of individual returns, there is an infinity of probable efficient portfolios; this conclusion could only be reached, after the materialization of the returns and the analysis of variances and covariances, that is, the evaluation of the beta of the sample calculated between each efficient portfolio and each asset, would be exactly linear with respect to the average return. Additionally, we state that the pricing model for financial assets can only be tested if the exact composition of the market portfolio is obtained, and in this situation, he suggests that the theory would be testable, however, only if all asset individuals were included in the sample. Aligned by Roll (1977), any substitution that presents the market portfolio will result in difficulties in projecting returns. Additionally, the options available in the market to replace the comparative parameter may present a strong correlation with the asset or portfolio analyzed, whether or not it is efficient in terms of average variance. Such an expressive correlation makes the exact composition of the market portfolio seem insignificant, while the use of different substitutes can lead to very different conclusions. This problem is called by the author as a comparative performance parameter error, as it refers to the use of an incorrect comparative portfolio in the CAPM theory tests.

Elbanan (2015) using the single factor CAPM, which is used by the Federal Reserve System to estimate the cost of equity for banks in six countries over the period 1990-2009, shows wide variation across banks, highlighting the difficulty of estimating expected returns using the CAPM. Following Amaya et al. (2015) adopted high-frequency data, and stated that the conditional capital asset pricing model (CAPM) can explain asset-pricing anomalies.

Vendrame & Tucker (2018) following the literature shows standard Capital Asset Pricing Model (CAPM) is simple, intuitive, and grounded in sound economic theory. Yet, almost half a century's worth of empirical testing has so far failed to demonstrate its relevance. One major reason given for the CAPM's empirical failure is that beta is not the sole measure of systematic risk. In other words, the standard CAPM does not hold. Another important explanation is that the CAPM may hold conditionally rather than unconditionally.
Cheung (2018) introduces a high-dimensional factor model with time-varying factor loadings. We show that both the factors and the time-varying loadings can be consistently estimated without rotations. We also propose a model-selection approach to determine the constancy of each factor loading for each cross-section. Theoretical results are supported by a simulation study. Following that same line, Reyes et al. (2019) propose and analyze an approach to estimate the systematic risk in capital asset pricing with interval-valued data,

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using as variables the high and low prices contained in the financial databases to explain the asset returns. Following this theory Chaudhary et al. (2020) show due to many theoretical and practical shortcomings of the traditional CAPM model, this study aims at analyzing the CAPM with possible extensions. The analysis aims to know the empirical soundness of Conditional Higher Moment CAPM in emerging India's capital market. The sample consists of 69 company's daily stock price data from April 2004 to March 2019 from NSE 100.

METHOD

The model described below are estimated using the methodology of Jagannathan & Wang (1996), was estimated using the generalized method of moments. With this, in search of answers to investors and the needs of the financial market, more complex variations emerged, with new theories, such as the Conditional Capital Asset Pricing Model or conditional CAPM (Tambosi Filho, 2003).

Haugen (1986) demonstrates that Black et al. (1972) considered that there should be a positive linear relationship between betas and expected rates of return. Subsequent to this study, Black et al. (1972) find in their CAPM test a positive relationship between profitability and beta.

Thus, the conditional CAPM can be represented in the figure below, as follows:
Conditional CAPM equation

$$E[Rit|It\text{-}1] = g0t-1 + g1t-1Bit-1$$

Source: Jagannathan & Wang (1996)

Where: It-1 is the information level of investors at the end of period t-1 and bit–1 = is the conditional beta of asset i in period t-1 defined as:

Conditional CAPM Beta Equation

$$Bit-1 = cov(Rit,Rmt| It-1)/Var(Rmt| | It-1)$$

Source: Jagannathan & Wang (1996)

In this CAPM variation, the information in the corresponding time is important, because the betas of both the assets and the risk price vary in the time of obtaining the information.

Jagannathan & Wang (1996) used as a proxy all stocks listed on the New York Stock Exchange (NYSE) and the American Stock Exchange (AMEX), a reasonable proxy for the return on the market portfolio of all assets. However, Fama & French (1992) found that, when using such a proxy, it was not sufficient for a satisfactory analysis of the CAPM performance. Thus, Jagannathan & Wang (1996), through observations of the study by Mayers (1972), included the return of human capital in their model. When human capital is also included in the market portfolio, the non-conditional model implicit in the conditional CAPM is able to explain more than 50% of the cross-sectional variation of the average return. This fact brought great advances to the model, explaining the returns of that market.

RESULTS

The regressions of the models described below are estimated using the methodology of Fama & MacBeth (1974), the same used by Jagannathan & Wang (1996). The model was estimated using the generalized method of moments, as described in the research

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Table 1
STATIC CAPM DATA WITHOUT HUMAN CAPITAL

Coefficients:	C0	Cibov	Cprize	cpib mer	Csize	R- Square
Estimate:	-1.10	-1.19	-3.74			13.20
t-value:	-0.99	-0.23	-0.80			
p-value:	0.00	0.00	0.00			
-t correction:	-0.34	-0.22	-0.35			
-p correction:	0.00	0.01	0.00			
Estimate:	-0.79	0.66	0.43		0.71	43.00
t-value:	-0.30	0.12	0.33		3.80	
p-value:	0.00	0.18	0.32		0.00	
t-correction:	-0.24	0.03	0.26		2.50	
P-correction:	0.00	0.06	0.45		0.00	

Source: Prepared by the authors

The results presented in the Table 1 above demonstrate that the t value for Cibov is -0.23. The regression R2 is only 13.20%. It is thus concluded that the cross-sectional variation of the average returns is still not well explained, that is, it is underestimated, when using the static CAPM without the inclusion of the market GDP, that is, without Human Capital. The model for error correction, according to the estimated value, is also not significant.

After error correction, which deals with the error term of the model, being able to use this term to link the short-term behavior of variables with their long-term value, that is, a means of reconciling the short-term behavior of a variable with its long-term behavior, it is concluded that the behavior of short-term variables is close to the long-term value. THE Cibov is not significantly different from zero. When the size variable is introduced in the model, a t-value of3.80 and R2 rises to 43.00%.

In this case, despite the increase in R2 from 13.20% to 43% and the fact that the model does not present significant changes after correction of errors, the model proves to be inconsistent, because even with the inclusion of the size variable, the expected improvement did not occur, showing no influence on the results, because the static model does not capture the effect of this variable. The analysis of the Brazilian market in this way is in the same direction as the conclusions reached for the North American market, found by (Jagannathan & Wang, 1996). The results obtained by them considered the static CAPM without Human Capital, the t-value for the Cibov of -0.28 and the R2 of the regression of 1.35%. Since, after correction, the values obtained when the size variable is introduced in the model also do not show significance, with Csize having a t-value of -2.30 and for R2 of 47.65%, which is consistent with what was found in the tests of this study, including its conclusions.

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Table 2
CONDITIONAL CAPM DATA WITHOUT HUMAN CAPITAL

Coefficients:	C0	Cibov	Cprize	cpib mer	Csize	R- Square
Estimate:	-1.67	3.97		-0.52		14.00
t-value:	-0.93	0.80		-0.80		
p-value:	0.00	0.00		0.00		
t-correction:	-0.19	0.13		-0.03		
p-correction:	0.00	0.01		0.04		
Estimate:	-0.96	1.58		-1.35	0.78	48.00
t-value:	-0.46	0.70		-0.66	4.20	
p-value:	0.00	0.00		0.00	0.00	
t-correction:	-0.12	0.02		-0.13	0.38	
P-correction:	0.02	0.03		0.15	0.00	

Source: Prepared by the authors

The results presented in the Table 2 above demonstrate that the estimated value of Cpib.mer, using the Fama-MacBeth (1974) methodology, it is not significantly different from zero. The t-value for Cpib.mer is -0.80 and the R2 is only 14%. Note that the R2 of this model is very close to the result found in the static CAPM model without Human Capital, 13.20%. However, after correcting the errors, it can be concluded that Cpib.mer becomes significantly different from zero compared to the model tests in the American market, carried out by (Jagannathan & Wang, 1996). When the size variable is introduced, the t-value changes to 4.20 and R2 grows to 48%. Despite the increase in R2, the model does not show consistency, as it is necessary to allow the beta to vary in the long term, so that the expected cross-sectional market returns can be explained.

Data also show that the R2 value of 48% is very close to that found in the static CAPM of 43% and the estimated value for the variable Cpib.mer, after correcting the errors, became significantly different from zero, facts that can be explained by the non-inclusion of market GDP.

Table 3
CONDITIONAL CAPM DATA WITH HUMAN CAPITAL

Coefficients:	C0	Cibov	Cprize	cpib mer	Csize	R-Square
Estimate:	-1.11	2.65	2.60	-0.59		18.00
t-value:	-0.85	0.70	0.30	-0.51		
p-value:	0.00	0.00	0.00	0.00		
-t correction:	-0.28	0.12	-0.19	-0.03		
P-correction:	0.00	0.03	0.18	0.12		
Estimate:	-0.67	10.75	1.86	-1.28	0.71	55.00
t-value:	-0.34	0.31	0.80	-0.43	3.50	
p-value:	0.00	0.00	0.00	0.00	0.00	
t-correction:	-0.11	0.02	0.10	-0.23	0.31	
P-correction:	0.23	0.12	0.56	0.01	0.00	

Source: Prepared by the authors

Thus, the conditional model seems to be more effective in explaining the average cross-sectional variation of returns in the Brazilian market than the non-conditional CAPM, consistent with the tests performed by Jagannathan & Wang (1996) for the American market. The results obtained by these authors, considering the conditional CAPM without Human Capital, the t-value for Cibov is 3.28 and the R2 of the regression is 29.32%. When the size variable is introduced in the model, the values change, being for Csize a t-value of -1.93 and for R2 of 61.66%.

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DISCUSSION

This study used the conditional CAPM model of Jagannathan & Wang (1996) applied in the American market. This model considers that the beta of each stock and the market risk premium vary over time. The authors relied on the methodology of Fama & MacBeth (1974), as we saw earlier, in the literature review.

Thus, for the application of this model in the Brazilian stock market, 40 stocks with the highest liquidity index in the Brazilian market were selected, divided into 5 (five) portfolios, each portfolio containing 8 stocks, during the period from 01.01.2008 to 12.31.2016 , as defined above, in the methodology of this study. It was evaluated whether this model is valid to explain the returns of the Brazilian stock market in the selected period, which is the research question of this study. Next, the results are described, with their analysis of the tests applied to the selected sample.

The static CAPM tests without Human Capital demonstrate that the model does not satisfactorily explain the cross-sectional returns of the Brazilian market, in the selected period of this research. Additionally, after the inclusion of the size variable in the models, the R2 of all models has a large growth. Considering this fact and what is described in the literature, it can be concluded that the results of this model for the Brazilian market demonstrate inconsistencies, considering the fact that they do not present changes in the parameters in the long term.

Therefore, the model does not satisfactorily demonstrate the reality of the market. Firstly, because it is known that the economic cycle is dynamic in most economies and, according to the models analyzed above, this variable was not considered. Second, because the market proxy would not be enough to represent any economy. The model needs to be improved with the inclusion of new variables that better represent the market. In this way, the static CAPM must be improved with the inclusion of new variables so that it can represent the market and its dynamism well. Even so, the static CAPM should not be discarded, as it is capable of explaining the market for a certain period of time.

The model seems to be able to capture the effects of the dynamics of the economy (quite significant during the selected period). When introducing the size variable, the models have a considerable increase in their R2, although it is important to emphasize that this variable seems to be more significant in the Brazilian market, probably as a result of the differences found in the composition of the new requirements of this market.

CONCLUSION

The static CAPM, without the inclusion of the human capital variable does not appear to fully explain the expected cross-sectional returns of the analyzed markets. After inclusion of variable *"size"*, the R^2 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 model 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. In relation to the conditional CAPM, without the inclusion of human capital variable we observed in the Brazilian case, the estimated value of C_{premim} is not significantly different than zero.

Finally, there is evidence that the conditional CAPM proposed by Jagannathan and Wang for the North American market is perfectly applicable to the Brazilian market. In general, the results obtained for the Brazilian market are similar to the results obtained for the

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American economy, when using this model. It is important to note that the results must be analyzed carefully, due to the sample size used. It is possible to evidence an acceptance of the model in the analyzed period, within the selected sample, but in a longer sample, it may be necessary to reject it. Therefore, further studies on the model are recommended, considering a longer period. Tests were not performed with the Static CAPM with Human Capital, as it is necessary to allow the beta to vary over time to explain the expected cross-sectional return of the markets.

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