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DIOGO AGUIAR DE OLIVEIRA

IMPLIED COST OF CAPITAL: TESTING THE VALIDITY OF DIFFERENT APPROACHES IN BRAZIL

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Dissertação de Mestrado apresentada ao Instituto COPPEAD de Administração, da Universidade Federal do Rio de Janeiro, como parte dos requisitos necessários à obtenção do título de Mestre em Administração.

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Approved on November 27th, 2019

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DEDICATION

I dedicate this dissertation to my entire family and my girlfriend.

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I would like to thank everyone from my family that assisted me during the master degree program, this includes my mother, my father, my brother, my grandparents and finally my girlfriend.

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ABSTRACT

OLIVEIRA, Diogo Aguiar de. **Implied cost of capital: testing the validity of different approaches in Brazil.** 2019. Dissertation (Masters in Business Administration) - COPPEAD Graduate School of Business, Federal University of Rio de Janeiro, Rio de Janeiro, 2019.

The purpose of this paper is to test the use of implied cost of equity capital (ICC) method in Brazil. Three different approaches were tested: the method based on analysts' forecasts based on Easton (2004); the Hou, van Dijk and Zhang (2012) method that uses the earnings forecasts from a cross-sectional model to proxy for cash flow expectations in the five classic ICC methods to calculate an aggregate ICC measure; and the option-implied cost of equity method from Camara, Chung and Wang (2009). The Camara, Chung and Wang (2009) approach presented superior results than the others when used to estimate future returns and when compared with the risk factor β and the risk-free rate – this approach has never been tested before in Brazil. On the other hand, Hou, van Dijk and Zhang (2012) approach has a great advantage: the data required for it is much easier obtained than the data required for the others. This is particularly important in a developing financial market like Brazil where several companies lack enough analysts' coverage and where the number of companies with liquid options is far from being large.

Keywords: implied cost of capital; cost of equity; analysts' forecasts; emerging markets

LIST OF TABLES

LIST OF ABREVIATIONS

CAPM	Capital Asset Pricing Model
CFO	Chief Financial Officer
DPS	Dividends per share
EP	Earnings to Price ratio
EPS	Earnings per share
ICC	Implied cost of capital
NYSE	New York Stock Exchange
PEG	Price-Earnings to growth ratio
RIV	Residual-Income Valuation
ROE	Return on equity
WACC	Weighted average cost of capital

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1 INTRODUCTION

The cost of equity capital plays a key role in several important decisions in the fields of finance, accounting and management, such as firm valuation, capital budgeting, corporate finance settings and project selection. The cost of equity capital can also be used as a proxy for expected return, so it plays an important role in portfolio management, stock picking and risk control.

A very important aspect is the sensibility of the cost of equity capital, as it is a required measure in order to calculate the weighted average cost of capital (WACC), so any slight variation in the its estimation may produce a significant difference in the firm valuation. Also, a company may choose to undertake or to reject a project depending on its cost of equity capital measure. Due to these facts, the cost of equity calculation must be as precise as possible in order to provide a reliable estimation.

In the current state, the most well-known and used cost of equity capital estimation approach is the classic Capital Asset Pricing Model (CAPM) of Sharpe (1964) and Lintner (1965). The CAPM is based on the idea of a linear relationship between the systematic risk factor (the β) and the cost of equity capital.

Despite the fact that the CAPM is the most used cost of capital estimation approach, it is a model under constant criticism. The major critics about the CAPM is regarding the use of historical data, and so it is a backward-looking method, thus not reflecting the expectations. Other critics about the model are regarding its unrealistic approaches such as the estimation of the market risk premium and the fact that only one risk factor (the β) would be take into account all the differences between two companies. Furthermore, it has also been pointed out that realized returns are a noisy proxy for expected returns.

Finance, accounting and economy academics tried to answer these critics by proposing forward-looking approaches and trying to be more precise. These proposed alternative methods focus on using expected data instead of historical data in the calculations of the cost of equity capital.

The alternative methods, however, do not converge by themselves in using the same idea or using the same variables, instead each one proposed a different formula. Some of these methods are based on analysts' forecasts for the cash flow expectations (these ones are called as Implied Cost of Capital in the literature), while there are other approaches are based on the current prices of stocks and stock options.

The purpose of this paper is to test and compare, in the Brazilian market, three alternative approaches of calculating the cost of equity. The first one is based on the discount rate that would make analysts' forecasts coherent with the current stock price. The second approach is the one proposed by Hou, van Dijk and Zhang (2012), which uses a cross-sectional model to proxy for cash flow instead of analysts' forecasts. The third approach is based on the current prices of stocks and stock options (the option implied cost of capital). By the law of one price, these three approaches should end up with equal results: this paper will, therefore, test this hypothesis.

The relevance of this study is related to the importance and need of reliable cost of equity estimations. As classical approaches are under constant criticism, alternative ones have been recently proposed. The alternative option implied cost of capital approach has never been tested in the Brazilian market, such that this article pioneers in comparing various forward-looking approaches. What also brings great relevance to the analysis developed in this study is the fact that, in Brazil, estimating cost of capital with traditional past-looking models is even more challenging. Due to historical high inflation and interest rate levels observed in Brazil, the historical market risk premium is usually found to be negative when applying CAPM. In addition, Fama and French (1992) factors do not seem to work efficiently in the Brazilian market (Mendonça, Campani e Leal, 2017).

2 LITERATURE REVIEW

The estimation of the cost of equity capital is a topic of great interest for both researchers and practitioners. A robust estimation is important not only for investors, who need to value stocks and companies, but also for the company itself, as, for example, for its capital budgeting decisions.

As shown in Bruner et al. (1998), the Capital Asset Pricing Model (CAPM) of Sharpe (1964) and Lintner (1965) is the most used method for estimating the cost of equity. Graham and Harvey (2001), in a survey with 392 CFOs, also found that the CAPM is the most used method. Other classic methods are Fama and French (1992) three-factor model and Carhart (1997) four-factor model, other methods also tried to include liquidity as a risk factors like Pastor and Stambaugh (2003), Liu (2006) and Drew, Naughton and Veeraraghavan (2003). Nevertheless, the CAPM continues to be largely used due to its simplicity and ease of use.

These classic methods, however, are under constant criticism as they rely, almost always, on historical data and are backward-looking methods while, for practical matters, the cost of equity is needed to discount future cash flows. Fama and French (1997) explained that the standard errors of cost of equity estimates are above 3.0% per year in US (using data from 1963-1994 and from NYSE, AMEX and NASDAQ exchanges). Elton (1999), on his turn, pointed out that realized returns are a noisy proxy for expected returns.

In order to address these negative critics, a first group of researchers proposed alternative approaches that would rely on market expectations instead of historical data. These approaches are generally called as the classic implied cost of capital (ICC) models by the market. The idea of them is to calculate the cost of equity based as the rate that discounting the expected cash flows of the firm would equal to the current stock price.

There are five models composing the classic implied cost of capital (ICC) methods: Gordon and Gordon (1997), Claus and Thomas (2001), Gebhardt, Lee and Swaminathan (2001), Easton (2004), and Ohlson and Juettner-Nauroth (2005). All of them rely on the analysts' forecast, but these methods are not homogeneous.

Claus and Thomas (2001) and Gebhardt, Lee and Swaminathan (2001) are based on the Residual-Income Valuation (RIV) theory, that claims that the market value is equal to the book value plus an infinite sum of discounted residual income (the amount that the net income grew above the cost of equity). In other words, if the net income of a company were growing exactly as the cost of equity, the book value should be equal to its market value, and so the cost of equity would be equal to its Return on Equity (ROE).

On the other hand, Gordon and Gordon (1997), Easton (2004) and Ohlson and Juettner-Nauroth (2005) are based on a finite horizon analysis. Gordon and Gordon (1997) considering just one period, Easton (2004) considering a two-period analysis and Ohlson and Juettner-Nauroth (2005) considering a five years' timeframe. These three models consider that a corporation cannot be expected to have an abnormally high or low growth rate forever and distinguish on how they should treat for these abnormal earnings growths.

A second method is presented by Hou, van Dijk and Zhang (2012): instead of using analysts' forecast (as the classic ICC models relied on), they proposed a cross-sectional model based on firm-level characteristics to proxy for cash flow expectations. This proxy is then used in the five implied cost of capital methods - Gordon and Gordon (1997), Claus and Thomas (2001), Gebhardt, Lee and Swaminathan (2001), Easton (2004), and Ohlson and Juettner-Nauroth (2005) - to compose a "composite ICC" measure. This model was tested in the United States stock market (Nasdaq, AMEX and NYSE) over the periods 1968-2008. Hou, van Dijk and Zhang (2012) also concluded that the result of his "composite ICC" method estimations is more reliable proxy for expected returns than the estimations of a composite ICC based on analysts' forecasts.

A third approach is based on calculating forward-looking estimates of cost of equity based on current prices of stocks and stock options – this is known as the option implied cost of capital approach. Bali and Hovakimian (2009), Ang et al. (2006), Ze-To (2012), and Camara, Chung and Wang (2009) all propose and discuss different methods of calculating the cost of equity with the relation between stock prices and stock options prices. Camara, Chung and Wang (2009) proposed a method an tested it with S&P 100 firms during the years of 1996 to 2005. Ze-To (2012) tested Camara, Chung and Wang (2009) method in the US market, considering stocks in the Dow Jones Industrial Average Index from the years 1998 to 2008, and found that the method is better to predict future returns than CAPM and Fama-French three-factor model. While Ang et al. (2006) and Bali and Hovakimian (2009) focus on the extra value that option volatility can bring to the cost of equity.

Some studies test one or more of these alternative approaches. Li, Ng and Swaminathan (2013) test different ICC methods and conclude that an aggregate ICC strongly predicts the future excess market returns at horizons from one month to four years in the United States market (NYSE/Amex/Nasdaq). Frank and Shen (2016) compare the classic methods (CAPM, Fama and French three-factor model and Carhart four-factor model) with Gordon growth model (1997) modified by Hou, van Dijk and Zhang (2012) and Gebhardt, Lee and Swaminathan (2001) in the United States market. Frank and Shen (2016) show how the cost of equity is measured impacts corporate investment, with companies with a high cost of equity investing more when using CAPM and investing less when using an implied cost of capital measure. They then conclude that the implied cost of capital can better reflect the time-varying required return on capital.

These ICC approaches have also been tested in international financial markets. Kitagawa and Gotoh (2011) compared five different approaches of ICC in the Japanese market. The approaches are: 1- a model proposed by Gebhardt, Lee and Swaminathan (2001); 2- a model suggested by Ohlson and Juettner-Nauroth (2005); 3- an expected earnings to price ratio (EP ratio); 4- a price/earnings to growth ratio (PEG ratio); and 5- a modified PEG ratio (the last two being proposed by Easton, 2004). They concluded that the PEG ratio and the modified PEG ratio (Easton 2004) models provided superior estimations in the Japanese market.

Lee, Ng and Swaminathan (2009) tested the validity of four different approaches of ICC in firms of G-7 countries (Canada, France, Germany, Italy, Japan, United Kingdom and United States). The approaches are: 1- Ohlson and Juettner-Nauroth (2005); 2- the Modified-PEG model of Easton (2004); 3- Claus and Thomas (2001); and 4- Gebhardt, Lee and Swaminathan. (2001). After several robustness checks, the authors concluded that the ICC approaches provide estimations coherent to the risk factors and with lower volatility than those provided by approaches based on realized returns.

In the Brazilian market, Martins et al. (2006) tested, for all companies in the Ibovespa benchmark in the year of 2005, if there are statistically significant difference between four different cost of capital approaches: 1- the ICC approach of Gordon (1962); 2- CAPM, 3- Arbitrage Pricing Theory; and 4- the ICC approach of Ohlson and Juettner-Nauroth (2005). The authors rejected the hypothesis that any of the approaches would result in the same result. Pereira (2016) tested, for the years 1994 to 2014, the validity of Hou, van Dijk and Zhang (2012) method with 5 ICC approaches in Brazilian companies and concluded that ICC methodologies are more efficient as a tool to infer future assets' performance than CAPM. She also proposed a small change in Hou, van Dijk and Zhang (2012) method to be used in Brazil.

This paper aimed to test these three literature methods in Brazilian market. Checking how they performed according to the theoretical classic literature. Furthermore, because of the need of reliable cost of equity estimations these three methods should provide similar estimations, therefore, it was also tested if they provided statistically significant different results. In the end, this paper also tested whether the Option implied cost of equity approach (Camara, Chung and Wang, 2009) is a good method to estimate the cost of equity in Brazilian market.

The remainder of this paper proceeds as follows: Section 3 describes how the data is acquired, how the calculations were done and the research design. In section 4, the results are presented and in section 5 we summarize the conclusions.

In this paper, it was found that the three implied cost of capital methods did not provide the same estimation. Furthermore, it was also found that the tested the option-implied cost of equity method, Camara, Chung and Wang (2009), had better results than the other implied cost of capital methods considering the risk-free rate and the stock βs. In terms of estimating returns, the Hou, van Dijk and Zhang (2012) had the greater R^2 when considering one-year future realized returns, and Camara, Chung and Wang (2009) had the greater R^2 when considering the compounded realized returns of the timeframe 2012-2018.

3 METHODOLOGY

We start describing the methods to estimate the cost of equity in order to understand which variables we work. The data needed is then described. Afterwards, there is a full explanation of how the calculations in this paper were performed.

To compare the approaches, one method of each literature was selected to compare with the others. Easton (2004) was selected as the representative of the methods based on analysts' forecasts because it was the last proposed method. Hou, van Dijk and Zhang (2012) use cross-sectional regression and then the composite ICC. For the methods based on option-implied cost of equity, Camara, Chung and Wang (2009) was the selected approach because it does not require the determination of a specific value for the preference parameter. Instead, it uses a set on parameters based on an optimization procedure. These three methods were compared to check the main hypothesis of this article:

- $H_{A,0}$: The choice of either of the 3 methods would give similar results.

These three methods were then compared with the actual returns of the stocks by using a R-square comparison. This comparison can suggest which method would be the most appropriate one to be used in Brazilian market. This analysis would also check if any of the methods result in cost of equity measures that are not coherent with the most accepted literature in terms of equity risk and discount rate. With this we have our second hypothesis that is investigated:

- $H_{B,0}$: The 3 methods provide consistent results when compared with the classic cost of equity literature.

3.1 METHODS AND DATA

Easton (2004) describes a model of earnings growth and uses this model to obtain estimates of the expected rate of return on equity capital. His idea is the same as in Ohlson and Juettner-Nauroth (2005) and it calculates the perpetual growth with a modification on Gordon (1962) formula. This model (often called the dividend discount model - DDM) establishes that the price today is given by the formula below:

$$P_0 = \frac{D_1}{r-g} \tag{1}$$

where:

r = expected rate of return (cost of equity);

D_1 = dividends, at date t =1;

P_0= current price per share, at date t = 0; and

g = the constant growth rate in perpetuity expected for the dividends.

From equation (1), Gordon and Gordon (1997) showed that:

$$r = \frac{D_1}{P_0} + g \rightarrow r = \frac{E[eps_1]*(1-\text{retention rate})}{P_0} + \text{retention rate} * \text{REI} \quad (2)$$

in which:

$E[eps_1]$ = expected earnings per share, at date t = 1; and

REI = the corporation's return on equity investment.

The formula above holds considering that dividends are the sole means for distributing funds to shareholders and that retained earnings are the sole source of funds for equity investment. Under the assumption that the firm cannot be expected to grow at an abnormal rate forever, the return of the investors is equal to the return of the firm, so REI = r, and:

$$r = \frac{E[eps_1]}{P_0} \quad (3)$$

Ohlson and Juettner-Nauroth (2005) argued that the model proposed by Gordon and Gordon (1997) does not consider expected growth in the eps beyond the first year, and also claimed that the model has a conceptual problem when not considering dividends per share as a source of value. Following these critics, they affirmed that the equation (3) is just a special case, and a general formula should take into account a term that would not only consider the eps expected growth but should also consider changes in expected dividend payments (dps). In other words, the critic is regarding the one-year horizon in Gordon and Gordon (1997), as according to Ohlson and Juettner-Nauroth (2005) this horizon should be bigger, because abnormal growth is not hardly observable in subsequent years. Ohlson and Juettner-Nauroth (2005) then proposed a model that considers growth in earnings, according to the following formula:

$$P_0 = \frac{E[eps_1]}{r} + \sum_{t=1}^{\infty} \frac{z_t}{(1+r)^t} \quad (4)$$

where r, $E[eps_1]$, P_0 and t are the same variables as described in Gordon and Gordon (1997) formula, and z_t represents the growth factor each year. This formula is a critic of the equation (3). Notice that equation (3) is a nested case when $z_t = 0$. The idea of Ohlson and Juettner-Nauroth (2005) is to include z_t as a factor that represents that the company earnings for the next terms is greater than the earnings of the previous one capitalized by the cost of capital ($eps_{t+1} > r * eps_t$).

This factor z_t can be consider both a long-term growth rate and a short-term growth rate. This formula is further explained in Hou, van Dijk and Zhang (2012) part as it is one of the methods that composes the composite ICC.

Easton (2004) diverges from the final result proposed by Ohlson and Juettner-Nauroth (2005) model, instead Easton (2004) proposes a perpetuity of a growing abnormal growth in earnings, as the formula below:

$$P_0 = \frac{E[eps_1]}{r} + \frac{1}{r} * \sum_{t=1}^{\infty} \frac{agr_t}{(1+r)^t} \tag{5}$$

where agr_t is the abnormal growth in earnings and it is calculated with the formula below:

$$agr_t = eps_{t+1} + r * dps_t - (1 + r) * eps_t \tag{6}$$

In other words, according to Easton (2004), the abnormal growth is the difference between the earnings per share of t+1 plus the capitalization of the dividends per share in t and the capitalized earnings per share in time t. Easton (2004) then proposed two special cases, the first is when we suppose a finite horizon by defining a perpetual rate of change in abnormal growth in earnings (Δagr) beyond the forecast horizon, so equation (5) becomes:

$$P_0 = \frac{E[eps_1]}{r} + \frac{agr_1}{r*(r-\Delta agr)}; \text{where } \Delta agr = \frac{agr_{t+1}}{agr_t} - 1 \tag{7}$$

The second special case is when it is assumed that $\Delta agr = 0$. In other words, it is assumed that next period's expected abnormal growth in earnings provides an unbiased estimate of all subsequent periods' abnormal growth in earnings. Using these two special cases together (finite horizon and $\Delta agr = 0$) in equation (7), Easton (2004) proposed formula is:

$$P_0 = \frac{E[eps_1]}{r} + \frac{E[eps_2]-E[eps_1]-r*(E[dps_1]-E[eps_1])}{r^2} \longrightarrow P_0 = \frac{E[eps_2]+r*E[dps_1]-E[eps_1]}{r^2} \tag{8}$$

With a reorganization in Equation (8), we can obtain the formula that is used in this paper for the cost of equity calculation:

$$r = \sqrt{\frac{E[eps_2]+r*E[dps_1]-E[eps_1]}{P_0}} \tag{9}$$

in which:

r = expected rate of return (cost of equity);

$E[eps_2]$ = expected earnings per share, at date t = 2;

$E[eps_1]$ = expected earnings per share, at date t = 1;

$E[dps_1]$ = expected dividends per share, at date t = 1;

P_0 = current price per share at t = 0.

The data required for Easton (2004) approach are the analysts' expected earnings for the next 2 years, the expected dividends for the next year and the market price of the stock. The stocks market prices were obtained from the "Economatica" database, and we obtained the other variables as listed below:

- Expected earnings for next year: obtained from the field "BEST_NET_INCOME" from the "Bloomberg" database – the mean of analysts' forecasts. As a measure of comparison with the other approaches, it was used the last day of June analysts' forecast of net income.
- Expected earnings for the second year ahead: Expected earnings for the next year multiplied by the long-term growth proposed by Claus and Thomas (2001): current risk-free rate minus 3%. Easton (2004) supposes that the growth from E[eps1] to E[eps2] is the same growth for all future periods ($\Delta agr = 0$), due to this fact the growth from the terms is considered a perpetuity growth.
- Expected dividends for next year: The expected dividends were calculated as the current payout ratio of the company multiplied by the net income. It is also important to observe that if a company has negative, zero net income, or had a payout ratio in the previous year higher than 100%, the payout ratio was calculated by Hou, van Dijk and Zhang (2012) proposed approach:

$$P_0 = \frac{E[eps_1]}{r} + \frac{agr_1}{r*(r-\Delta agr)}; \text{where } \Delta agr = \frac{agr_{t+1}}{agr_t} - 1 \quad (10)$$

The second method to be analyzed in this article is Hou, van Dijk and Zhang (2012). They use a cross-sectional model to proxy for cash flows instead of analysts' forecasts. Their method, differently than the implied cost of capital methods based on analysts' forecasts, is based on accounting factors and how these factors historically correlate with the firm earnings. This estimation of earnings is than used in a composite implied cost of capital, that is an average of five implied cost of capital methods.

The idea of this cross-sectional model is that the earnings of a company can be explained by some past accounting factors, such as total assets, dividends paid, earnings and the accruals.

Sloan (1996) defined these accruals as the change in net working capital minus depreciation and she also showed that the accruals are strongly negatively related to subsequent returns.

To compute this cross-sectional model, the data from the previous ten years of the accounting factors is used in regressions to explain the earnings, afterwards, with the coefficients of the regressions, Hou, van Dijk and Zhang (2012) method estimate the earnings for the next 5 years. Hou, van Dijk and Zhang (2012) showed that this estimation for the earnings is superior to analysts' forecasts in term of coverage, forecast bias, and earnings response coefficient.

This method relies on the hypothesis that the company will maintain roughly constant how these accounting factors relate to future earnings. The formula for this cross-sectional model is built on regressions using the previous ten years of data in the equation below:

$$E_{i,t+\tau} = \alpha_0 + \alpha_1 A_{i,t} + \alpha_2 D_{i,t} + \alpha_3 DD_{i,t} + \alpha_4 E_{i,t} + \alpha_5 NegE_{i,t} + \alpha_6 AC_{i,t} + \varepsilon_{i,t+\tau} \quad (11)$$

in which:

$E_{i,t+\tau}$ = earnings of the firm i in year t + τ (τ = 1 to 5) for the regressions. After the coefficients are obtained, then it is used as the expected earnings for firm i in the next 1 to 5 years;

$A_{i,t}$ = total assets of the firm i in year t;

$D_{i,t}$ = dividend payment of the firm i in year t;

$DD_{i,t}$ = dummy variable of the firm i in year t: 1 for firms paying dividends, 0 for firms not paying dividends;

$NegE_{i,t}$ = dummy variable of the firm i in year t: 1 for firms with negative earnings and 0 for firms with positive earnings;

$AC_{i,t}$ = accruals of the firm i in year t.

The accruals in the equation (11) was calculated in the same way used in Hou, van Dijk and Zhang (2012), that described then as: *"Accruals are calculated using the cash flow statement method as the difference between earnings and cash flow from operations"*. The formula used by their method, was the one proposed by Dechow, Sloan and Sweeney (1995):

$$AC_{i,t} = (\Delta CA - \Delta cash) - (\Delta CL - \Delta STD) - Depreciation \quad (12)$$

in which:

ΔCA = is the change in current assets of the company from time t-1 to t;

ΔCL = is the change in current liabilities of the company from time t-1 to t;

ΔSTD = is the change in short-term debt of the company from time t-1 to t.

The equation (11) calculates the expected earnings to be used as the main input in the five models in the "composite" implied cost of capital measure. Another important advantage of this method compared to Easton (2004), is that as it calculates the implied cost of equity without needing to rely on analysts' forecasts, it can be used for companies with no or small coverage from the analysts. Hou, van Dijk and Zhang (2012) proposed this "composite" measure so their results would not be driven by any specific method.

Regarding the data required on Hou, van Dijk and Zhang (2012) cross-sectional approach, the following accounting data from the years 1997 to 2018 were required: total assets, earnings, dividends paid, depreciation and working capital measures. All these data were obtained exclusively from the Economatica database.

The "composite" implied cost of capital is the average of the following 5 different models:

(1) Gordon and Gordon (1997): Also known as FHERM model (Finite Horizon Expected Return Model). This model derives from the formula explained in equation (1) and is explained in equation (3).
The data required to calculate this method of implied cost of equity is only the expected earnings per share for the next term and the price per share at the end of the year, according to equation (3). The expected earnings were obtained from equation (11), the price per share and the number of shares were obtained from the Economatica database.

(2) Gebhardt, Lee and Swaminathan (2001): This model is based on the Residual Income Valuation idea. Gebhardt, Lee and Swaminathan (2001) proposed that the market value of a company is equal to the book value of the company plus an extra value. In the long-term this extra value would converge to zero and so market value would be equal to book value.

The formula proposed by this model is:

$$M_t = B_t + \sum_{k=1}^{\infty} \frac{(ROE_{t+k} - r) * B_{t+k-1}}{(1+r)^k} \tag{13}$$

However, as in the original article, the authors used a 12-years' timeframe for the analysis, in this article the formula used will be the below:

$$M_t = B_t + \sum_{k=1}^{11} \frac{(ROE_{t+k} - r) * B_{t+k-1}}{(1+r)^k} + \frac{(ROE_{t+12} - r) * B_{t+11}}{r * (1+r)^{11}} \tag{14}$$

in which:

M_t = is the market value of the firm in year t;

B_t = is the book value of the firm in year t;

ROE_t = is the return on equity of the firm in year t;

r = is the equity cost of capital.

In other words, the market value is composed with the book value plus the extra value. This extra value is the difference between the ROE_t and the cost of equity capital, multiplied by the book value of last year (B_{t-1}) for 11 years. In year 12 the value reaches a perpetuity with no growth rate.

The data required for Gebhardt, Lee and Swaminathan (2001) model are the book value and market value of the company, the expected return on equity for the next 12 years. The data for the market value and book value for the last year were acquired from the Economatica database.

The estimation of ROE_t and B_t were the same used by the authors in the original article. For the next 3 periods, ROE_t was calculated with the projected earnings obtained from Hou, van Dijk and Zhang (2012) approach over over B_{t-1}, and B_t was calculated as B_{t-1} plus the expected earnings (equation 6) minus the expected dividends. After that the ROE_t linearly converges to the sector average, that is the long-term ROE_{12}. For the long-term ROE_{12}, it was considered the benchmark from the Damodaran website. The six companies that were used in this paper, as it is further explained in Part 3.2, used data according to their industry. Petrobras used the benchmark of the industry “Oil/Gas (Integrated)”, Gerdau used “Steel”, Vale used “Metals and Mining” and both Banco do Brasil, Itau-Unibanco and Bradesco were classified as “Banks (Regional)”.

(3) Claus and Thomas (2001): This method is very similar to the Gebhardt, Lee and Swaminathan (2001). It is also based on the residual income valuation idea, but it uses a 5 years’ timeframe and considers a perpetuity growth rate. The formula proposed by Claus and Thomas (2001) is:

$$M_t = B_t + \sum_{k=1}^{5} \frac{(ROE_{t+k} - r) * B_{t+k-1}}{(1+r)^k} + \frac{(ROE_{t+5} - r) * B_{t+4}}{(r-g) * (1+r)^5} \quad (15)$$

in which:

M_t = is the market value of the firm in year t;

B_t = is the book value of the firm in year t;

ROE_t = is the return on equity of the firm in year t;

g = the perpetuity growth rate;

r = is the equity cost of capital.

The formula is very similar the one presented in equation (14), however this method requires a small number of estimations for future years, instead it relies on a well-estimated perpetuity growth rate.

The data required for this method are the book value and market value of the company, the return on equity for the next 5 years and the expected perpetuity growth. The data for the market value and book value for the last year were acquired from the Economatica database.

The estimation of ROE_t and B_t were the same used by the authors in the original article. ROE_t was calculated with the projected earnings obtained from Hou, van Dijk and Zhang (2012) approach (equation 11) over B_{t-1}, and B_t was calculated as B_{t-1} plus the expected earnings (equation 11) minus the expected dividends. The expected dividends were calculated in the same way calculated in Gebhardt, Lee and Swaminathan (2001) and Easton (2004) models.

The g (perpetuity growth rate) was estimated following Claus and Thomas (2001), where g is set to current risk-free rate minus 3%. So, it was used SELIC minus 3% as the perpetuity growth rate.

(4) Easton (2004): This method not only composes the composite ICC, but also is the first method that was considered in the analysis of the article. It was already explained in equation (9).

(5) Ohlson and Juettner-Nauroth (2005). This is the method that was used as basis for Easton (2004). Differently than Easton (2004), Ohlson and Juettner-Nauroth (2005) describes the additional factor in equation (4) as the difference between the $E[eps_t]$ and $E[eps_{t+1}]$ minus the reinvested retained earnings. This formula, for the measure (z_t), is as below:

$$z_t = \frac{E[eps_{t+1}] - E[eps_t] - r*(E[eps_t] - E[dps_t])}{r} \tag{16}$$

From equation (16), Ohlson and Juettner-Nauroth (2005) proposes two different growth terms, one long-term and one short-term. The short-term growth rate (g) is described as the growth required in $E[eps_t]$ to reach z_t, as in the following equation:

$$z_1 = \frac{E[eps_1]*\widehat{g_2}}{r} \tag{17}$$

where g_2 is the short-term growth rate and $\widehat{g_2} = g_2 - r$.

The long-term growth (γ) is the factor that could explain z_{t+1} based on values of z_t. This value has a similar idea of a perpetuity growth rate and is described as below:

$$z_{t+1} = \gamma * z_t \tag{18}$$

where γ is the long-term growth rate and $1 \leq \gamma < 1 + r$.

The fact that $\gamma < 1 + r$, is a necessary and sufficient condition for the convergence of the term $\sum_{t=1}^{\infty} \frac{z_t}{(1+r)^t}$ from equation (4). By considering this convergence and both growth rates the equation (4) is equal to:

$$P_0 = \frac{E[eps_1]}{r} + \frac{z_1}{(1-r)-\gamma} \rightarrow P_0 = \frac{E[eps_1]}{r} + \frac{g_2-(\gamma-1)}{r-(\gamma-1)} \tag{19}$$

With a reorganization of the equation above, by sending r to the left-hand-side of the equation:

$$r = A + \sqrt{A^2 + \frac{E[eps_1]}{P_0} * (g_2 - (\gamma - 1))} \tag{20}$$

where: $A = 0.5 * [(\gamma - 1) + \frac{E[dps_1]}{P_0}]$.

Ohlson and Juettner-Nauroth (2015) method requires two different growth rates for the calculations however it has some very positive points such as not needing to estimate dividends further than the first year and not needing to calculate future accounting measures like methods Gebhardt, Lee and Swaminathan (2001) and Claus and Thomas (2001), which required the estimation of the future book values of the company.

The data required for Ohlson and Juettner-Nauroth (2015) method, according to equation (20) were both growth rates, the expected earnings for the next term, the expected dividends for the next term and the price per share at the end of the year. The current price was obtained from Economatica database. The expected earnings obtained from Hou, van Dijk and Zhang (2012) approach (equation 11) and the expected dividends were calculated in the same way calculated in Gebhardt, Lee and Swaminathan (2001), Claus and Thomas (2001) and Easton (2004) models.

For the determination of the γ (long-term growth rate) in were estimated following the same approach used by Hou, van Dijk and Zhang (2012). This γ (long-term growth rate) was calculated exactly as the g (perpetuity growth rate) in Claus and Thomas (2001). In other words, g is set to current risk-free rate minus 3%, for the Brazilian market, it was used SELIC minus 3%.

For the calculation of the short-term growth rate g_2, this article followed the approach used by Hou, van Dijk, Zhang (2012) that was first proposed by Gode and Mohanram (2003). Instead of using the short-term growth rate based on the growth of the second year, this method uses the average of earnings growth in year 3 and in year 5, following the equation below:

$$g = 0.5 * \left(\frac{E[eps_{t+3}] - E[eps_{t+2}]}{E[eps_{t+2}]} + \frac{E[eps_{t+5}] - E[eps_{t+4}]}{E[eps_{t+4}]}\right) \tag{21}$$

In summary, Hou, van Dijk and Zhang (2012) method is one that simulates the expected earnings by using accounting data and then use this data in the five implied cost of equity approaches in order to calculate the composite ICC, that is the estimated cost of equity in Hou, van Dijk and Zhang (2012) method.

For the calculation of this composite ICC, the data from the 5 methods were considered when possible. Some of the methods are unable to be calculated with Hou, van Dijk and Zhang (2012) estimations for net income. For instance, Easton (2004) requires that the estimated earnings for the 2nd year to be greater than the estimated earnings for the next year and Gordon and Gordon (1997) requires to have estimated earnings positive. When any of these methods resulted in a cost of equity negative or impossible to calculate, these results were not considered in the calculation of the composite ICC.

Finally, the third alternative cost of equity capital approach is presented by Camara, Chung and Wang (2009). They use current prices of stocks and stock options to estimate the cost of equity. The model is based on a no-arbitrage idea with the aggregate wealth of the economy, so the pricing kernel is determined to avoid arbitrage opportunities to arise in the economy.

The main difference between this model and the Black-Scholes model (1973) is regarding the risk preference parameter, x. According to Schroder (2004), the Black-Scholes model (1973) implicit pricing kernel is a “preference-free” model, while Camara, Chung and Wang (2009) uses a model considering a risk preference parameter, x, that $0 \leq x < 1$. It is also important to observe that Camara, Chung and Wang (2009) model converges to Black-Scholes (1973) model when x = 0.

The formulas for the theoretical prices of the call option and the put option are as described below:

$$P_c = e^{-rT} * x[S_0 * e^{\mu T} * N(d_1) - K * N(d_2)] + e^{-rT} * (1 - x) * [S_0 * \left(\frac{e^{rT} - x * e^{\mu T}}{1 - x}\right) * N(d_3) - K * N(d_4)] \tag{22}$$

$$P_p = e^{-rT} * x[K * N(-d_2) - S_0 * e^{\mu T} * N(-d_1)] + e^{-rT} * (1 - x) * [K * N(-d_4) - S_0 * \left(\frac{e^{rT} - x * e^{xT}}{1 - x}\right) * N(-d_3)] \quad (23)$$

where:

$$d_1 = \frac{\ln(\frac{S_0}{K}) + \left(\mu + \frac{\sigma^2}{2}\right) * T}{\sigma * \sqrt{T}}$$

$$d_2 = \frac{\ln(\frac{S_0}{K}) + \left(\mu - \frac{\sigma^2}{2}\right) * T}{\sigma * \sqrt{T}}$$

$$d_3 = \frac{\ln(\frac{S_0}{K} * (\frac{e^{rT} - x * e^{\mu T}}{1 - x})) + \frac{\sigma^2}{2} * T}{\sigma * \sqrt{T}}$$

$$d_4 = \frac{\ln(\frac{S_0}{K} * (\frac{e^{rT} - x * e^{\mu T}}{1 - x})) - \frac{\sigma^2}{2} * T}{\sigma * \sqrt{T}}$$

with:

N(.) is the cumulative distribution function of the standard normal;

S_0 = current stock price;

K = strike price;

T = time to maturity;

r = interest rate;

σ = stock volatility;

x = risk preference parameter;

μ = the rate of return required by stockholders, option implied cost of equity.

According to Camara, Chung and Wang (2009), the equations (22) and (23) can be solved for three unknowns x, σ and μ by minimizing the sum of squared differences between market prices and theoretical prices of options, finding the μ (Option implied cost of equity). In other words, this means minimizing the following equation for firm i:

$$\sum_{i=1}^{n} \sum_{j=1}^{m} (C_i\,(K_j) - c_i(K_j | x, \mu_i, \sigma_i))^2 \quad (24)$$

in which:

C_i(.) and c_i(.) denotes the market and the theoretical call prices respectively;

m = the number of different contracts with different strike prices K_j for the firm i;

n = the number of different companies.

It is also important to observe that, theoretically, the risk preference parameter x is unique across the n assets in a specific point in time.

The data required for Camara, Chung and Wang (2009) approach, described in equations (22) and (24), is all related to option characteristics and market prices of both the options and the stocks. The data of the options were obtained from the website www.grafbolsa.com and the market price of the stocks was obtained from the Economatica database.

In order to maintain the comparison of the three models the date of reference of each year was the last workday in the month of June. So, the data from the stocks and the stock options from the 12 months prior to this data of reference were used in the calculation of Camara, Chung and Wang (2009) estimation for each year.

In total 4,455 call options were used in the analysis from 2012 to 2018, with the following breakdown: 359 in 2012, 517 in 2013, 703 in 2014, 542 in 2015, 717 in 2016, 869 in 2017 and 748 in 2018.

3.2 DATA TREATMENT, RESTRICTIONS AND CALCULATIONS

The data used in this article was secondary data obtained from the following financial and accounting databases: Economatica, Bloomberg and the website www.grafbolsa.com. Prior to the description of data, there are two very important definitions that need to be done: Timeframe and number of companies that would be considered in the analysis. The number of companies was the most restricted universe in this analysis as liquidity was a problem for the options in Brazilian financial market. These liquidity limitations were required because of the Camara, Chung and Wang (2009) approach.

The companies considered in the analysis were Banco do Brasil, Bradesco, Gerdau, Itau-Unibanco, Petrobras and Vale. In the universe of 7 years, from 2012 to 2018. The criteria for the definition of these companies was the stock having at least 5 options in the year that were traded at least 30 days. The 30 days restriction was due to the fact that the database for the options, the website www.grafbolsa.com, only store data of options that had at least 30 days of trade, this is the liquidity criteria of the website. Regarding the 5 options minimum restriction it was used in order to have a minimum number of contracts to be market relevant.

Another relevant limitation is regarding the Hou, van Dijk and Zhang (2012) method. Asit requires 10 years of accounting data for the earnings estimation, some companies that had no accounting data available for the analysis, due to foundation reasons, were not considered. This limitation affects specifically OGX (OGXP3) and Brasil, Bolsa, Balcão (B3SA). In order to have a good comparable universe for the analysis, the timeframe was defined as the 2012-2018 (7 years of analysis). Increasing the timeframe of the analysis would not provide a better conclusion as the Brazilian option market had the liquidity issues and so the universe of comparable companies would not be the same.

For the Hou, van Dijk and Zhang (2012) approach, the Stata software was used in order to run the regressions as in equation (11). For the other approaches, the calculations were performed in Microsoft Excel Software and the Solver were used.

Regarding observations of the cost of capital estimations, the first important one to be done is regarding Easton (2004) method. When solving the formula of this method, which was presented in equation (9), the considered value is the positive root as the negative root is meaningless in terms of cost of capital.

Another observation to be done is regarding Hou, van Dijk and Zhang (2012) method. The problem is that the Hou, van Dijk and Zhang (2012) model requires calculations of working capital of the companies and classification of debt in short-term or long-term, and the classification of what is cash and equivalents. When considering the financial analysis of financial companies, items like capital expenditure, working capital and debt are not clearly defined as explained by Damodaran (2009). Due to this, the value of the “Accruals” ($AC_{i,t}$) in equation (12) was considered zero for the companies of the bank industry in this analysis: Itau=Unibanco, Bradesco and Banco do Brasil. It is also important to explain that in Hou, van Dijk and Zhang (2012) original article, utilities and financials were excluded from the analysis.

As Hou, van Dijk and Zhang (2012) method predict the relation of the accounting data with the earnings for 1 to 5 years ahead, 35 regressions were needed in total. Each year had 5 regressions like:

- Estimate the earnings for the company in t + x (x = 1, 2, 3, 4 or 5), using information available in t.

For instance, the oldest data were required to estimate t + 5 from 2012. The regression was done to explain how accounting data from full year 2011 would relate to the projected earnings of 2016, and so estimate. For this t + 5 estimation, the earnings from 2011-2002 were explained by the accounting data from 2006-1997.

For the comparison of the three models, a Friedman two-way analysis of variance by ranks test was done on the R-software. Afterwards, the three models were compared against each other with Wilcoxon-Mann-Whitney tests, also done on the R-software.

4 RESULTS

This section contains the results of the estimation of the cost of equity by the three models, the further tests comparing the three models against themselves and with the most accepted literature.

4.1 RESULTS OF THE THREE MODELS AND COMPARISON

After the calculations and procedures described in the methodology, the following results were obtained:

Table 1. Results of the three models – cost of equity capital estimations

Easton (2004) - Implied (analysts forecasted earnings)							
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
BANCO DO BRASIL	15.14%	11.01%	13.20%	19.22%	19.36%	18.24%	9.15%
BRADESCO	10.86%	8.03%	10.72%	12.34%	15.96%	12.99%	8.54%
GERDAU	11.18%	5.30%	7.35%	9.18%	3.13%	6.94%	5.73%
ITAÚ UNIBANCO	10.69%	8.95%	11.75%	12.58%	14.61%	12.86%	8.03%
PETROBRAS	11.04%	10.67%	11.05%	12.09%	7.32%	9.37%	7.09%
VALE	12.78%	15.28%	15.05%	49.37%	14.15%	15.75%	7.60%
AVERAGE	11.95%	9.87%	11.52%	19.13%	12.42%	12.69%	7.69%
AVG. w/o GERDAU	12.10%	10.79%	12.35%	21.12%	14.28%	13.84%	8.08%

Camara, Chung and Wang (2009) - Option Implied Cost of Equity							
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
BANCO DO BRASIL	25.14%	22.41%	24.92%	22.07%	33.47%	31.78%	13.64%
BRADESCO	11.08%	9.91%	26.19%	27.04%	16.27%	20.97%	9.08%
GERDAU	11.74%	15.21%	15.12%	24.22%	24.97%	23.86%	11.06%
ITAÚ UNIBANCO	25.14%	15.58%	23.42%	37.78%	36.46%	23.68%	12.31%
PETROBRAS	22.74%	19.36%	36.73%	29.83%	38.58%	35.32%	15.32%
VALE	25.14%	11.58%	10.35%	11.27%	15.54%	15.91%	10.59%
AVERAGE	20.16%	15.68%	22.79%	25.37%	27.55%	25.25%	12.00%
AVG. w/o GERDAU	21.85%	15.77%	24.32%	25.60%	28.06%	25.53%	12.19%

Hou, van Dijk and Zhang (2012) - Cross-Sectional Earnings and Composite ICC							
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
BANCO DO BRASIL	19.40%	17.15%	23.12%	16.37%	36.30%	16.53%	14.06%
BRADESCO	11.96%	8.63%	9.98%	9.49%	13.52%	9.30%	7.19%
GERDAU	13.81%	10.97%	18.19%	25.37%	412.58%	61.60%	23.81%
ITAÚ UNIBANCO	13.52%	11.23%	9.70%	7.82%	12.22%	7.70%	6.26%
PETROBRAS	15.51%	13.39%	14.68%	11.81%	46.42%	21.42%	10.96%
VALE	24.19%	17.42%	12.18%	14.62%	59.66%	6.61%	6.68%
AVERAGE	16.40%	13.13%	14.64%	14.25%	96.78%	20.53%	11.49%

AVG. w/o GERDAU	16.92%	13.56%	13.93%	12.02%	33.62%	12.31%	9.03%

Regarding this data, one observation must be done about the result of Hou, Van Dijk and Zhang (2012) method for the cost of capital of Gerdau in the year of 2016. This estimation was affected by several unusual facts that happened in the same year:

(1) The expected earnings for t+1 in 2016 from the equation (11) was negative. Thus, the cost of equity cannot be calculated in Gordon and Gordon (1997) model and it would result in a very high rate in Easton (2004) model;

(2) In the end of the year 2015, Gerdau had a book value greater than the market value. Also, the expected earnings for t+1 in 2016 was negative, but the expected earnings for t+2, t+3, t+4 and t+5 were positive. These factors made the models that rely on the Residual Income Valuation assumption suppose a very high cost of equity. The Residual Income Valuation supposes that the market value of a firm is the book value plus an extra value that is related to the abnormal growth in earnings that the company is going to have above the cost of equity in the next years. The methods that rely on the Residual Income Valuation assumption were Claus and Thomas (2001) and Gebhardt, Lee and Swaminathan (2001). So, in order to make the expected earnings in t+1 minus the expected earnings in t+2, t+3, t+4 and t+5 enough to reduce the book value into the market value, the equations (8) and (9) resulted in a very high cost of equity.

After this observation, to compare the results of the three models and check the hypothesis $H_{A,0}$, it was done a Friedman test. The use of Friedman test was required as a non-parametric test because the data presented in Table 1 is not of independent data. It should be analyzed as paired data (for instance, the estimated cost of equity for Petrobras in 2012 in each one of the three models should be matched in the comparison_). According to Siegel and Castellan (1988, p. 174-175), “the Friedman two-way analysis of variance by ranks tests the null hypothesis that the k repeated measures of matched groups come from the same population or populations with the same median”. The result of this test was:

Table 2. Result of the Friedman test comparing the three models

	Chi-Squared	p-value
Friedman test	26.6190	0.0000

As p-value is 0.0000 (<0.05) the Friedman test rejected the null hypothesis of the three coming from the same population or having the same median. However, according to Siegel and Castellan (1988, p. 174-175), Friedman test rejects the null hypothesis if “at least one pair of conditions has different medians”. Due to this, the three models were also compared two-by-two.

Before doing the two-by-two comparison, a normality test was needed in order to check which test would be the best. It was done a Shapiro-Wilk test for the data of each one of the models presented in the Table 1. The result was the rejection of the hypothesis of the data of both models coming from a normal distribution, as explained in the table below:

Table 3. Shapiro-Wilk test of normality on the three models

Method	W	p-value
Easton (2004)	0.6508	0.0000
Camara, Chung and Wang (2009)	0.9295	0.0124
Hou, van Dijk and Zhang (2012)	0.2697	0.0000

With this result, the t-test to compare both samples should not be used, instead the three models were compared two-by-two by the non-parametric Wilcoxon signed-rank test. According to Siegel and Castellan (1988, p. 87-88), the Wilcoxon signed-rank test compares two related samples, analyzing the difference score for any matched pair with the null hypothesis that two treatments are equivalent (i.e., they are samples from populations with the same medians and the same continuous distribution). The following results were found:

Table 4. Wilcoxon signed-rank test comparing the models 2 by 2

Paired Methods	V	p-value
Easton (2004) with Camara, Chung and Wang (2009)	65	0.0000
Easton (2004) with Hou, van Dijk and Zhang (2012)	258	0.0147
Camara, Chung and Wang (2009) with Hou, van Dijk and Zhang (2012)	646	0.0142

At a 0.05 level of significance, the Wilcoxon signed-rank test rejected the null hypothesis of the results from any two of the three models compared being from populations with the same medians and the same distribution.

As the result on Table 4 was affected by the estimation of Gerdau 2016, a new Wilcoxon signed-rank test was estimated removing the data of Gerdau from the analysis. The findings are stated on Table 5: it shows that, if not considered the cost of equity estimations of Gerdau, the Wilcoxon signed-rank test did not reject the null hypothesis that the estimations from models

Easton (2004) and Hou, van Dijk and Zhang (2012) are of populations with the same median and the same distribution. This is somewhat coherent as they came from similar ideas regarding the Implied Cost of Equity theory but using different proxies for expected earnings (Hou, van Dijk and Zhang (2012) uses cross-sectional model while Easton (2004) uses analysts' forecasts).

Table 5. Wilcoxon signed-rank test comparing the models 2 by 2, not considering the cost of equity estimations of Gerdau

Paired Methods:	**V**	**p-value**
Easton (2004) with Camara, Chung and Wang (2009)	56	0.0000
Easton (2004) with Hou, van Dijk and Zhang (2012)	245	0.2585
Camara, Chung and Wang (2009) with Hou, van Dijk and Zhang (2012)	529	0.0002

However, once again, at a 0.05 level of significance, the Wilcoxon signed-rank test rejected the null hypothesis of the results from the models Camara, Chung and Wang (2009) being from population with the same median and the same distribution of any of the other two models - Easton (2004) and Hou, van Dijk and Zhang (2012). In other words, it was concluded that the results from model Camara, Chung and Wang (2009) is different from the other two, with this the initial hypothesis of this paper, the $H_{A,0}$: The choice of either of the 3 methods would give similar results, was rejected.

4.2 ADDITIONAL TESTS

According to the CAPM, the cost of equity of a firm is based on just one risk factor. This risk factor, also called the market risk factor is the β. Theoretically, the greater the β, the greater should be the cost of equity capital. Considering this, the cost of equity estimated with the three models should have a positive linear relation with the β.

For the estimation of the market risks (β), as proposed by Kitagawa and Gotoh (2011), it was used the daily stock returns over the year prior to the year of the estimated cost of equity of each model. The data of all these returns were obtained from obtained from Economatica database considering the adjusted stock returns (adjusted closing prices). The adjusted closing prices correct the stock returns for all dividends, splits and other events (like in the case of VALE5 being converted to VALE3 in 2017).

For the reference of the companies, the stock selected was the most liquid, so respectively: BBAS3, BBDC4, GGBR4, ITUB4, PETR4, and VALE3. For the reference of the market, it was used daily returns of the Ibovespa index. The result of the estimations of these βs is presented in the table below:

Table 6. The βs and the returns of the companies each year

The βs	2012	2013	2014	2015	2016	2017	2018
BANCO DO BRASIL	0.9610	0.9944	0.7075	1.5929	1.6197	1.6597	1.6631
BRADESCO	0.9824	0.7815	0.8264	1.3106	1.2693	1.2802	1.2258
GERDAU	1.2658	1.2125	0.8361	0.8141	1.0490	1.6923	1.3458
ITAÚ UNIBANCO	1.0405	0.9768	0.7921	1.2004	1.1932	1.1887	1.1337
PETROBRAS	0.9199	1.1916	1.1877	1.9177	1.9432	2.0145	1.5348
VALE	0.9716	0.9782	1.0176	0.9835	1.4365	1.6377	1.0365
Average β	1.0235	1.0225	0.8945	1.3032	1.4185	1.5789	1.3233
Average β w/o Gerdau	0.9751	0.9845	0.9062	1.4010	1.4924	1.5562	1.3188

Realized Returns	2012	2013	2014	2015	2016	2017	2018
BANCO DO BRASIL	15.68%	5.21%	4.21%	-31.49%	99.40%	16.85%	52.40%
BRADESCO	17.95%	-6.30%	25.45%	-29.52%	73.70%	33.46%	29.89%
GERDAU	25.72%	3.71%	-46.75%	-49.95%	133.33%	15.17%	22.60%
ITAÚ UNIBANCO	1.69%	6.70%	25.30%	-12.00%	49.97%	30.57%	33.51%
PETROBRAS	-6.91%	-9.03%	-37.60%	-33.13%	121.94%	8.27%	46.84%
VALE	13.40%	-10.94%	-34.55%	-37.32%	98.24%	63.74%	31.81%
Average	11.26%	-1.77%	-10.66%	-32.24%	96.10%	28.01%	36.17%
Average w/o Gerdau	8.36%	-2.87%	-3.44%	-28.69%	88.65%	30.58%	38.89%

To check the relation between the estimated βs and the estimated cost of equities of each model, from Table 1, three regressions were done on Stata, with the following results:

Table 7. Regression between the β of the companies and the estimated cost of equity of each model

Method	β (Beta)	Intercept	F-statistic
Easton (2004)	-0.0063	0.1295	0.8473
p-value	(0.847)	(0.003)	
Camara, Chung and Wang (2009)	0.0861	0.1073	0.0310
p-value	(0.031)	(0.034)	
Hou, van Dijk and Zhang (2012)	-0.0207	0.2928	0.9439
p-value	(0.944)	(0.434)	

The result was that only Camara, Chung and Wang (2009) model had a statistically significant, at 0.05 level of significance, positive relation from β with the estimated cost of equity capital. As an additional test, as Hou, van Dijk and Zhang (2012) model was affected by the estimated cost of equity of Gerdau in 2016. So, the data from Gerdau was excluded from the models in a new regression:

Table 8. Regression between the β of the companies and the estimated cost of equity of each model not considering the cost of equity estimations of Gerdau 2016

Method	β (Beta)	Intercept	F-Statistic
Easton (2004)	-0.0117	0.1467	0.3728
p-value	(0.744)	(0.003)	
Camara, Chung and Wang (2009)	0.0976	0.0987	0.0276
p-value	(0.028)	(0.078)	
Hou, van Dijk and Zhang (2012)	0.1031	0.0319	0.0615
p-value	(0.061)	(0.643)	

The results show again that only Camara, Chung and Wang (2009) model had a statistically significant, at 0.05 level of significance, positive relation from β with the estimated cost of equity capital. However, Hou, van Dijk and Zhang (2012) model also had a statistically significant positive relation considering a 0.10 level of significance. In any case, in both examples the Camara, Chung and Wang (2009) method performed better in this test in both scenarios.

In another comparison of the results of the three models with the classic literature of cost of capital, the results of each model, presented on Table 1, were compared with the risk-free rate. According to CAPM, the cost of equity is the risk-free rate plus beta times the equity risk premium. As the beta was already tested in this paper, here the criteria were that every cost of capital estimated by each model should be at least the risk-free rate.

The risk-free rate considered in the analysis was the year-end Selic of the year before and the expected end of year rate by the last “Focus – Central Bank” report from the prior year. The comparison with the last rate of the year before was the one most coherent with how the methods were calculated and the calculation with the expected rate for the year regarding “Focus – Central Bank” report is to check how the cost of equity estimates would reflect the expected rate. The results were the following:

Table 9. Selic rates considered in the comparison each year

Interest rate	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Expected SELIC from last Focus report of the prior year	**9.50%**	**7.25%**	**10.50%**	**12.50%**	**15.25%**	**10.25%**	**6.75%**

SELIC at the end of the prior year	**11.00%**	**7.25%**	**10.00%**	**11.75%**	**14.25%**	**13.75%**	**7.00%**

Table 10. Number of companies with cost of capital lower than the expected SELIC rate from last Focus report of the prior year

Method	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Easton (2004)	0	1	1	3	4	2	1
Camara, Chung and Wang (2009)	0	0	1	1	0	0	0
Hou, van Dijk and Zhang (2012)	0	0	2	3	2	3	2

Table 11. Number of companies with cost of capital lower than the SELIC at the end of the prior year

Method	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Easton (2004)	2	1	1	1	3	4	1
Camara, Chung and Wang (2009)	0	0	0	1	0	0	0
Hou, van Dijk and Zhang (2012)	0	0	1	2	2	3	2

Considering the literature of cost of capital and regarding the relationship between risk and return, the cost of equity should be greater than the risk-free rate. However, tables 10 and 11 showed that every model failed to follow this rule in the timeframe of 2012-2018, every model had a cost of equity estimation lower than the risk-free rate at least once. Nevertheless, it must be observed that Camara, Chung and Wang (2009) method performed much better than the others by having a much smaller number of cost of equity estimations lower than the risk-free rate.

A third analysis with these methods was regarding which one could explain better the actual cost of equity. While cost of capital is not an easily observable variable, it is considered as a proxy for expected returns. With this, in order to determine the cost of capital method explains the actual cost of capital better, the analysis must be done with the future realized returns.

Different articles used different approaches in other to analyze the quality of ICCs as proxies for expected returns by examining their relation with future realized returns. Guay, Khotari and Shu (2011) analyzed the five traditional implied cost of capital methods by making regressions of the one-year-ahead stock returns with the estimations of these methods. Easton and Monahan (2005) checked the four of the five traditional implied cost of capital methods by analyzing the correlation of their estimations with the realized returns one-year-ahead and made regressions to analyze how these estimations relate to several factors and variables important to the cost of capital (beta, book-to-market ratio, size of the company, and others).

Following these studies, Hou, van Dijk and Zhang (2012) compared the composite ICC results with the results of an analyst-based composite ICC by using deciles of companies ranking them regarding their performance for the next one, two and three years. It is important to observe as they described that the inclusion of realized returns for the second and third years is important because the ICC represents a measure for all future periods (thus beyond the first year). Pereira (2016) used the same approach in her paper to test Hou, van Dijk and Zhang (2012) approach in Brazilian market, however quintiles were used instead of deciles (because the amount of companies was smaller), and also comparing the Hou, van Dijk and Zhang (2012) estimations with the traditional CAPM estimations in this analysis.

In this paper, as the number of companies considered in the analysis is smaller, the comparison of the methods was done in two different ways by using R^2. It is also important to say that all returns considered in this analysis were holding period returns, so considering both capital gains and dividends.

The first analysis was done just by comparing the cost of equity estimated by each method (in Table 1) with the actual realized returns of the year (in Table 6). The result of this first analysis was the following:

Table 12. R^2 of each method when analyzing one year

Method	**R^2**
Easton (2004)	0.0425
Camara, Chung and Wang (2009)	0.0088
Hou, van Dijk and Zhang (2012)	0.2297

The second analysis was the one considering more the appropriate concept of the cost of equity as the long-term required rate of return. As explained by Hou, van Dijk and Zhang (2012) the ICC represents the measure for all future periods, in other words, this paper makes the analysis considering that the cost of equity is the estimated compounded average of all future (yearly) returns of the stock.

In order to do this comparison, the actual returns were compounded year by year from 2012 and 2018, the estimated cost of equity from each one of the three models were also compounded in the same timeframe, and then the R^2 was calculated from these two data. This comparison measures which of the three methods would be the one, that selected in 2012 and used continuously in this timeframe, explained the actual realized returns better. Below is the calculation of this compounded data.

Table 13. Compounded rates of the realized returns and the methods

Compounded Realized returns	2012	2013	2014	2015	2016	2017	2018
BBAS3	15.7%	21.7%	26.8%	-13.1%	73.3%	102.5%	208.5%
BBDC4	17.9%	10.5%	38.6%	-2.3%	69.7%	126.5%	194.2%
GGBR4	25.7%	30.4%	-30.6%	-65.2%	-18.9%	-6.6%	14.5%
ITUB4	1.7%	8.5%	36.0%	19.6%	79.4%	134.3%	212.8%
PETR4	-6.9%	-15.3%	-47.2%	-64.7%	-21.6%	-15.1%	24.7%
VALE3	13.4%	1.0%	-33.9%	-58.6%	-17.9%	34.5%	77.3%

Easton (2004) - Implied (analysts forecasted earnings)	2012	2013	2014	2015	2016	2017	2018
BANCO DO BRASIL	15.1%	27.8%	44.7%	72.5%	105.9%	143.4%	165.7%
BRADESCO	10.9%	19.8%	32.6%	49.0%	72.7%	95.2%	111.8%
GERDAU	11.2%	17.1%	25.7%	37.2%	41.5%	51.3%	60.0%
ITAÚ UNIBANCO	10.7%	20.6%	34.8%	51.7%	73.9%	96.2%	112.0%
PETROBRAS	11.0%	22.9%	36.5%	53.0%	64.2%	79.5%	92.3%
VALE	12.8%	30.0%	49.6%	123.4%	155.0%	195.2%	217.6%

Camara, Chung and Wang (2009) - Option Implied Cost of Equity	2012	2013	2014	2015	2016	2017	2018
BANCO DO BRASIL	25.1%	53.2%	91.4%	133.6%	211.8%	310.9%	366.9%
BRADESCO	11.1%	22.1%	54.1%	95.7%	127.6%	175.3%	200.3%
GERDAU	11.7%	28.7%	48.2%	84.1%	130.1%	184.9%	216.5%
ITAÚ UNIBANCO	25.1%	44.6%	78.5%	146.0%	235.7%	315.1%	366.2%
PETROBRAS	22.7%	46.5%	100.3%	160.1%	260.4%	387.7%	462.4%
VALE	25.1%	39.6%	54.1%	71.4%	98.1%	129.6%	153.9%

Hou, van Dijk and Zhang (2012) - Cross-Sectional Earnings and Composite ICC	2012	2013	2014	2015	2016	2017	2018
BANCO DO BRASIL	19.4%	39.9%	72.2%	100.4%	173.1%	218.3%	263.0%
BRADESCO	12.0%	21.6%	33.8%	46.4%	66.2%	81.7%	94.8%
GERDAU	13.8%	26.3%	49.3%	87.1%	859.2%	1450.2%	1819.2%
ITAÚ UNIBANCO	13.5%	26.3%	38.5%	49.3%	67.6%	80.5%	91.8%
PETROBRAS	15.5%	31.0%	50.2%	67.9%	145.9%	198.6%	231.3%
VALE	24.2%	45.8%	63.6%	87.5%	199.3%	219.1%	240.4%

From the data in Table 13, the R^2 was calculated. The result of this analysis with the six companies, both including and excluding the Gerdau in the comparison was:

Table 14. Result of the R^2 in the compounded comparison

Method	R^2	R^2 without Gerdau
Easton (2004)	0.2240	0.2092
Camara, Chung and Wang (2009)	0.2575	0.2750
Hou, van Dijk and Zhang (2012)	0.0024	0.0991

While in the first analysis, presented in Table 12, the Hou, van Dijk and Zhang (2012) performed better in terms of R^2, when considering a long-term analysis, Camara, Chung and Wang (2009) performed better as shown in Table 14. In other words, for the timeframe considered in this analysis (2012-2018), Camara, Chung and Wang (2009) was the implied cost of capital method that predicted better the future realized returns, considering this buy-and-hold idea.

5 CONCLUSION

The implied cost of capital (ICC) approaches started as alternatives to calculate the cost of capital without relying on historical data that classic methods rely (most notably CAPM, Fama and French, and Carhart models). On the other hand, the ICC methods have one strong disadvantage: they require the estimation of long-term variables, like expected earnings for t+5 and long-term expected ROE. In the United States these variables are obtained from analysts' forecasts. These estimations are not easily obtained in less developed financial markets, like in Brazil, which translates to an important obstacle when applying ICC approaches.

An answer to this disadvantage was proposed by Hou, van Dijk and Zhang (2012) to use estimations from a cross-sectional model based on accounting data instead of using analysts' forecasts. This was a very important alternative as it increased the universe of countries and companies that could use the implied cost of capital methods.

Camara, Chung and Wang (2009) proposed the calculation of implied cost of equity based on the stock prices and the stock option prices. This method, while tested as strong, has the disadvantage that it can only be applied when the company also has stock options. In less developed financial markets this method cannot be easily applied.

This paper tested if selection of the implied cost of equity approach would be irrelevant to the result. After the non-parametric test of Friedman and the Wilcoxon signed-rank test, the null hypothesis of irrelevance of method selection was rejected. This result was in line with Martins et al. (2006), when they tested and rejected the hypothesis of the methods CAPM, Arbitrage Price Method (APM), Ohlson and Juettner-Nauroth (2005) and Gordon (1962) resulting in the same estimated cost of equity.

In the additional tests, for the timeframe considered in the analysis, this paper also found that Camara, Chung and Wang (2009) presented a better result compared with the classic literature and by using it to explain compounded returns. By comparing Easton (2004) and Hou, van Dijk and Zhang (2012) in these tests, they obtained diverging results with the former being better in explaining the future compounded returns and the later having more coherent results when considered the stock βs and the risk-free rates.

This paper concludes that Camara, Chung and Wang (2009) showed a good result in the timeframe analyzed in Brazilian market, however with a strong limitation that it can only be applied in companies that have stock options issued. Regarding Hou, van Dijk and Zhang (2012) and Easton (2004), when these methods were compared without Gerdau, the Wilcoxon-signed rank test failed to reject the null hypothesis (results are from populations with the same medians and the same continuous distribution). While they have mixed results in terms of performance in the additional tests, it is important to consider that the Hou, van Dijk and Zhang (2012) has a strong advantage that it can be used in a much broader universe of companies, just requiring 10 years of previous accounting data. Furthermore, Pereira (2016) tested the ICCs by using Hou, van Dijk and Zhang (2012) cross-sectional model as proxies for analysts' forecasts and concluded that the ICCs are better in previewing future asset performance then the traditional CAPM. In this paper, Camara, Chung and Wang (2009) performed even better than those ICC methods (Easton, 2004; Hou, van Dijk and Zhang, 2012).

For future research, we suggest expanding the universe of companies, to strengthen our results, as well as to use these approaches to measure the market risk premium, as in Easton (2004) and in Hou, van Dijk and Zhang (2012). The approach of Camara, Chung and Wang (2009) could also be tested, since there are traded options of ETFs from Ibovespa (BOVA11). We hope this paper encourages practitioners to use ICC approaches to estimate equity cost of capital in Brazil.

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