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The use of Fx derivatives and the cost of capital: Evidence of Brazilian companies

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ABSTRACT

Large corporations have been using derivative instruments as a tool to protect their indirect exposure, as FX risks. A sample with 47 non-financial Bovespa Listed Brazilian companies from 2004 and 2010 was used to test the hypothesis that use of derivatives as a risk management policy tool reduces companies' cost of capital. In contrast to other countries, results rejected this hypothesis, showing that in Brazil there is a positive relationship between using these tools and cost of capital. However, a more in-depth analysis based on the TACC model for a Brazilian company, this hypothesis was not rejected after the 2008 crisis.

1. Introduction

The volatility of financial markets may hurt companies' financial health, since it directly affects their cash flow (Chowdhry, 1995). In the past, abrupt market moves were accepted by investors as the cause of companies' poor performance. Nowadays, due to the growth in futures and derivatives exchanges in emerging markets (in terms of both size and variety of instruments), investors increasingly expect this type of risk to be mitigated, without affecting companies' results and growth prospects.

Also, the events triggered by the global crisis in recent years played a crucial role in increasing investor requirements in terms of non-correlation between companies' earnings and atypical market movements. According to Rossi (2009), companies based in emerging markets suffer more from FX market volatility than companies from more developed economies. For these reasons, emerging country companies have

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started to increasingly invest in a conservative risk policy, by using derivative instruments correctly and with greater transparency in their earnings releases to the market. For example, Kim and Sung (2005) investigated determinants and the hedging instruments used by Korean firms after 1997 Asian Crisis. Schiozer and Saito (2007) found evidences that Brazilian firms use derivatives for hedging puporse.

However, Farhi and Borghi (2009) show that companies from key emerging markets such as Brazil, China, South Korea, India and Mexico posted heavy losses as a result of the financial crisis of 2008 — some examples are shown in Table 1. Many companies had derivatives-structured operations in their books that (after the strong volatility that hit markets and the consequent losses) were more speculative than protective. According to Guttmann (2008, p.20-1), "derivatives instruments helped reduce the different types of risk related to finances, and were also excellent speculative tools."

In Brazil in particular, demand for derivatives instruments to help manage risk is in line with global averages, despite the high volatility of FX and interest rate markets (as per Table 2 below). Of these two variables, the FX rate is considered to be the most sensitive and seems to affect companies more on the operational front, both in terms of revenue and debt denominated in other currencies.

The cost of capital is an important indicator and is strongly used by companies to take a whole host of decisions — e.g. acceptance of new projects and capital allocation decisions. As a result, it is important to consider the adequate calculation of a company's cost of capital based on its risk exposure, since this will directly affect management's incentive when choosing projects and, consequently, the company's performance/growth.

As it is known, calculating cost of capital, first studied in groundbreaking terms by Modigliani and Miller (1958; 1963) as per their theory of capital structure, does not consider a company's risk capital. Prakash Shimpi (2002) and Doherty (2005) discuss an alternative form for calculating a company's cost of capital breaking down the capital structure into three forms of financing: own capital, indebtedness and risk capital.

Companies' risk management is a very wide-ranging and extremely relevant subject. And despite a whole host of studies on the matter, few offer an in-depth analysis. However, despite the absence of a wide-ranging bibliography, the vast majority of companies currently do adopt some methodology to control their indirect exposure, i.e. interest rates, FX rates and commodity prices. Based on Aysun and Guldi (2011) and Rossi (2012), firms' hedging activities affetc the companies' foreign exchange exposure modeling.

The aim of this work is to study the influence of the use of (derivatives-based) hedge instruments on a non financial Bovespa listed company's cost of capital. The hypothesis to be tested is that the use of these instruments reduces the cost of capital, making it more advantageous to invest in a company. The contribution lies in the act of presenting a relationship between a company's hedge and the benefit provided by this hedge in terms of reducing the company's cost of capital.

This piece is structured as follows: Section 2 presents a brief theoretical revision; Section 3 describes the methodology applied; Section 4 presents the database; in Section 5 we analyze the results obtained; and Section 6 presents the conclusions.

2. Theoretical framework

There are numerous essays and academic pieces on corporate risk management policy, and the same is true when the subject is cost of capital. However, there is scant literature relating and discussing the two matters together, as we propose to do in this study.

A company's risk management is the responsibility of management, which has the task of assuming positions aligned with stockholder interests. The importance, metric and decisions related to risk management are extremely relevant given the agency cost involved. The main objective of risk management, as argued by Stulz (1996), is to eliminate the probability of negative results in both extremes — which could lead the company to go bankrupt. What we see in practice, however, is that the use of derivatives instruments does not have the sole objective of protecting a company's results. As shown by Tufano (1996), management tends to prioritize its own personal interests, mainly when their gains are directly related to their company's results.

In the last two decades of research, some academics started to discuss the influence of risk management policies on capital structures (in terms of composition and the numerous possible uses and applications). A

Table 1
Derivatives losses of emerging market-based companies.

The table below aims to show how companies from the main emerging markets, from both the eastern and western worlds, suffered from the high volatility of global FX markets. This higher volatility stemmed from the appreciation of the US dollar, as a result of a flight-to-quality movement and higher risk aversion by investors in general. Due to these losses, many companies had to either be sold or incorporated, or even file for bankruptcy (i.e. South Korean company Taesan LCD Company).

Company	Country	Sector	Losses (US$mn)
Citic Pacific	Hong Kong	Infrastructure	2.400
Contr. Com. Mexicana	Mexico	Retail	2.200
Aracruz	Brazil	Pulp	2.130
Grupo Votorantim	Brazil	Diversified	1.040
Cemex	Mexico	Cement	711
Gruma	Mexico	Food	684
China Cosco Hlds Co.	China	Shipbuilding	577
Air China Ltd.	China	Airlines	450
Sadia	Brazil	Food	360
Alfa	Mexico	Diversified	273
Vitro	Mexico	Glass	227
Axis Bank	India	Bank	139

Source: Farhi and Borghi (2009).

noteworthy concept in these discussions was the definition and use of risk capital. Merton (1993) defined risk capital as the lowest amount that can be invested in a given company to guarantee the liquidity of its net assets vis-à-vis a risk-free investment. In that work, the author developed an analysis on the process of taking decisions and risks, which revolves around the concept of risk capital. Merton also introduces another interesting concept on the economic cost of risk capital: it is the spread on the insurance – in this case, insurance per se, or the act of hedging — which, according to him, are the stem for forming asymmetry of information and agency costs.

The current concept of capital structure was introduced by Modigliani and Miller (1958), whose work defines a company's cost of capital as the average, weighted by funding costs, of the proportions of debt and own capital of each company's capital structure. Prakash Shimpi (2002) developed a model that tries to bring the company's risk management in line with its cost of capital. The proposed insight is that when a company uses a financial instrument for hedging purposes, it doesn't need that much own capital invested to guarantee its credit needs. Thus, excess capital is freed up when derivatives instruments are used for

Table 2
Comparison of use of derivatives between countries and researching period.

Comparison chart of studies taken in the last 16 years with companies in several countries in order to understand the use of derivatives as a strategy for protecting indirect risks. It can be seen that over time, both the response rate and the percentage of companies saying they use derivatives has increased significantly. The exception is Brazil. Despite being the last country to be surveyed, Brazil's response rate was below the average of other countries. This shows the low level of disclosure of Brazilian companies.

Country	Year	Number of companies that received questionnaire	# of respondents	Response rate (%)	% of respondents using derivatives
Brazil	2004	378	74	19.6	57
US	1998	1928	399	20.7	50
US	1995	2000	350	17.5	41
US	1994	2000	530	26.5	35
Germany	1998	368	126	34.2	78
Holland	1998	167	84	50.3	60
United Kingdom	2002	401	173	43.1	67
Sweden	2003	261	134	51.3	59
Sweden/Korea	2001	250/387	103/60	41.2/15.5	57/62

Source: Own author.

hedging purposes, and this excess capital is considered a source of extra-equity capital, supplementing the capital position represented by own capital and debt. This excess capital is called Risk Capital, or the company's risk capital, and is the capital needed to guarantee the desired return without exposure to indirect risks. The cost of risk capital is different to the cost of the company's own capital, and thus should be calculated separately to reach the company's total cost of capital. Hence the name suggested by the author: TACC (Total Average Cost of Capital). Consequently, any change in the capital-debt relationship will obligatorily affect the cost of capital, since by suggestion of this paper, there is a negative ratio between the use of hedge instruments and the company's cost of capital.

The central idea of Shimpi's concept is his perception of risk capital as a source of funding. The model is based on the idea that companies, in order to reduce their risk level (or value at risk, VaR), may enter into hedge operations featuring the use of FX derivatives, or issue additional shares. If the company opts for the first option, it will be freeing up own capital. Below we show the proposed equation for calculating the company's total capital:

$$\text{Total Capital} = \text{Debt} + \text{OwnCapital} + \text{RiskCapital} \tag{1}$$

As a result, treating risk capital as a source of funding leads us to a different formula for the weighted average cost of capital (WACC), since now we have three alternative funding sources: own capital, debt and capital freed up by hedge, herein called *H*.

The extended version of the cost of capital is thus expressed by the following formula:

$$\text{TACC} = k_e * \frac{E}{V} + k_d * (1 - T_c) * \frac{D}{V} + k_h * \frac{H}{V}, \quad \text{where} \tag{2}$$

- k_e cost of own capital;
- k_d cost of third-party capital;
- k_h cost of capital freed up;
- E Equity;
- D Debt
- H Hedge;
- V Enterprise Value (E + D + H);
- T_c Corporate Income Tax rate.

To calculate the cost of the freed-up capital, the equation below mirrors the proposed methodology:

$$k_h = \frac{\text{HedgePremium}}{\text{FreedCapital}} \tag{3}$$

Doherty (2005) produced a study in which he discusses Shimpi's proposal (2002). Despite agreeing with the idea that using hedging instruments frees up the company's capital, and that this protection impacts companies' cost of capital, he argues that the proposed model could undervalue the new cost. Due to this undervaluation, companies' management teams could take wrong decisions such as, for example, deciding to go ahead with value-destructive projects. Another possible consequence is breaking the following market rule: “Law of one price,” thereby creating arbitrage opportunities since stock trading on exchanges takes into account the conventional calculation of the WACC (Weighted Average Cost of Capital) methodology.

In Brazil, analysts and investors mainly study the WACC and its influence in terms of valuing projects. There is a massive search for the ideal model for estimating companies' cost of capital, given the importance of this indicator in the strategic decisions taken in a company's history. Minardi et al. (2007) produced a study that considers the process of estimating the cost of capital of non-listed companies, with the aim of studying the best form of managing projects. Other academic pieces study WACC with the purpose of understanding companies' capital structure. Minardi and Sanvicente (2003) used market data to calculate companies' cost of capital, in order to gauge and deduce what market participants believe to

be the optimal capital structure. Kiyokawa (2010) performed a similar study, based only on theory and without using empirical data.

In parallel, a current emerged in Brazil aimed at understanding Brazilian non-financial companies' FX exposure and its effects on business management policies and the value of these companies. Tavares and Sheng (2007) presented a form of estimating FX exposure, which could help improve risk management policies. In other studies, Rossi (2008) and Serafini and Sheng (2011) tested the influence of companies' FX exposure on their market value. Rossi (2009) showed evidence that Brazilian companies subject to floating FX market risks make strong use of derivatives to mitigate their indirect exposure and adjust possible volatilities in their cash flows.

3. Sample

The source of the data collected were two databases that are very popular in the market: for companies' accounting and financial data, we used Economática®; and for market data, we used Bloomberg L.P.©. To collect the data related to FX exposure, risk management policy and percentage of protected (hedged) exposure, we also analyzed companies' Quarterly and Annual Earnings Reports.

There are 466 Bovespa listed companies, 360 are non-financial companies according to Economatica®. This study used the data of 47 non financial listed companies. Due to limited access to the credit rating of companies, the analysis started on 31 March 2004 and ended on 30 June 2010.

The criteria used to select the sample are the following. First, to reduce the implication of liquidity, only companies with total assets of over R$10 million and with daily trading volume over R$300 k in at least one share class (i.e. common or preferred stock) are considered. In addition, the sample only included companies with public information that allow us to estimate the cost of equity and debt. The parameters were payout ratio, dividend outlook and credit rating. However, not all the non financial companies had systematically available data for the entire period; the sample was reduced to 47 companies.

The information on the use of currency derivative is also required. In our sample, all companies that have registered the currency derivative loss and gain (for either cash flow or foreign currency debts) in their earning report use these operations for the hedging purposes. It is important to note that the statement of purpose of the hedge is not necessarily to be reported together with a company total gain and loss with derivative. Sometime it is reported under the comments from executive to shareholder, and sometime it is found in the explanatory note related to financial policy.

Unfortunately, as suggested by Table 2, the level of disclosure in companies' balance sheets is still insufficient to obtain a minimum sample enabling us to perform a more in-depth analysis. Only one company from the Brazilian airline segment has (in its balance sheets) the information needed to calculate the TACC. The period selected to analyze this company was from 31 December 2007 to 30 June 2010.

To study companies' cost of capital (WACC and TACC), we define below the calculations for the variables that comprise the equations to be estimated.

The calculation of each company's beta was estimated for each quarter, considering the equation of the model proposed by Scholes and Williams (1977). As this paper doesn't take a global investor perspective, the global beta methodology for emerging markets firms is not employed (Harvey, 2000; Mishra and O' Brien, 2005).

The expected return of the market portfolio was calculated using the Gordon Model which requires ROE and dividend payout ratio to be constant overtime to calculate $g = (1\text{-payout}) * \text{ROE}$. Unfortunately, not all the companies selected had sufficient data for this calculation. Some of these companies didn't distribute dividends to its investors in some fiscal years; others didn't provide year-end dividend outlook. The retention rate was not also clear in their payout policy. Thus, it was selected the companies with consistent payout ratio information and we estimated the return of the market portfolio since 2004. The above equations are described in Appendix A.

With the obtaining of the beta and of the market portfolio return, we used the Selic rate (252-day LFTs, or *Financial Treasury Notes*) – considering the final rate of each quarter from 2004 onwards – to find each company's rate of return from own capital, via the CAPM model also described in Appendix A. The cost of

third-party capital was calculated based on Minardi and Sanvicente (2003), via the use of correct market data as described in Appendix B.

Finally, with all the estimated variables and with the Debt and Equity data of each company, we were able to form the two estimated series: (i) WACC, according to Eq. (C.1) of Appendix C; and (ii) TACC, according to Eq. (2).

The concept of insurance, described by Shimpi (2002) and necessary for calculating TACC, was used considering the company's purchase of an option to hedge its unprotected exposure. Thus, the Hedge Premium is the cost of the option, calculated via the formula proposed by Black and Scholes (1973). For a fuller analysis, it was considered three possible strategies: the option purchased may be in the money (ITM), at the money (ATM) or out of the money (OTM). All the options proposed have a 3-month maturity.

According to Shimpi, the acquisition of an insurance that frees up capital should maintain the same VaR of the company's assets if hedge is not taken out and if the company decided to enter into a larger funding operation to cover the losses. As a result, to find the freed-up capital amount, we calculated the percentage of the company's unprotected FX exposure and the VaR of this unmatched position for confidence intervals of 95% and 99%. This amount was considered as variable *H* of Eq. (2).

To calculate the cost of risk capital, k_h, we used Eq. (3) and the cost of the option considered in each case as a hedge premium.

4. Methodology

4.1. Methodology

Having gathered all the necessary data for the 47 companies and performed the relevant calculations, we can carry out the proposed tests. For all the Brazilian companies, it was possible to assemble the WACC series since 2004, which it was considered as the model-dependent variable. For companies whose data are not available since the start of 2004, the study period was limited to the dates on which the data start to be released or after the IPO of these companies.

The test aimed to verify the hypothesis that companies' cost of capital is negatively related to the use of derivatives instruments — in other words, companies with this characteristic in their risk management policy tend to have a lower cost of capital, as previously discussed. This work sought to estimate this influence via regression of the cost of capital calculated with the control variables defined in the subsequent section. The methodology used in the regression was the Data Panel (cross-section with random effects), as described by Wooldrige (2007).

This methodology was applied since it enables an analysis of the data over time, and not just for identical periods. It also enables the analysis to be made for more than one set of data, which in this case are represented by the various companies featured in the study. The estimation used considered random effects because the dummy variable does not vary over time. Below it is indicated the equation used, considering the control variables which will describe in the following section:

$$\begin{aligned} \text{WACC} &= c + \beta_1 * \text{Dummy} + \beta_2 * \text{Leverage} + \beta_3 * \text{Size} + \\ &+ \beta_4 * \text{Profitability} + \beta_5 * \text{Risk\_Op} + \beta_6 * \text{Average\_Duration} \end{aligned} \tag{4}$$

The analysis of the coefficients β_i encountered for the explicative variables, and the analysis of their respective levels of significance, enables us to check the possible influence of control variables on companies' cost of capital.

4.2. Definition of control variables

Since the main objective of this work is to verify if the use of FX derivatives by companies influences their cost of capital, a dummy variable was defined as is worth 1 if the company does use FX derivatives and 0 if it doesn't. Also, it was chosen other control variables based on existing finance literature. Tufano (1996) recalls the question of leverage as a variable that could affect companies' cost of capital. Perobelli and Fama (2003) and Serafini and Sheng (2011) discuss the question of the size of companies, while Brito et al. (2005) and Tavares and Sheng (2007) point to the question of companies' level of profitability. Again,

Brito et al. (2005) use Operational Risk as a variable to be studied. Finally, we selected the average debt maturity of the companies, as defined by Kiyokawa (2010). Table 3 contains all the variables, a small description and their form of calculation.

5. Results

The results are shown in Table 4. It was observed that the Profitability, average maturity and Operating Risk control variables were statistically insignificant at a level of 5%, and were thus removed from the model. The Size and Leverage dummy variables were statistically significant at 5%. With the exception of the dummy variable, whose coefficient was positive, the other variables behaved in line with the proposed theory. As a result, it was possible to reach the final model, as described in Table 5.

Analyzing the result presented, it can be seen that the positive relationship between the dummy variable and the response variable leads to rejection of the initial hypotheses.

Due to this rejection of the hypothesis, and with the aim of trying to understand a possible change of behavior in companies' risk management policies after the 2008 financial crisis, a new test was performed with the inclusion of another dummy variable, which was classified as *dummyt*. This variable was defined as 0 for data prior to 2008 and as 1 for post-2008 data. The objective is to test a new hypothesis: namely, that for the post-2008 period companies are most alert to possible risks stemming from a very volatile market. Thus, it was expected these companies to have changed their risk-taking decision strategies, producing a negative relationship between *dummyt* and the cost of capital. Firstly, we generated interaction between the new *dummyt* variable and the other control variables, in order to try and capture some change in the behavior of the variables after the cut-off date, mainly in relation to the coefficient sign

Table 3
Description and methodology for calculating control variables.

Definitions of the variables chosen to test the hypothesis that the use of derivatives influences a company's cost of capital. The dependent variable is the WACC, and the test variables are defined below. Column 2 features a succinct description of each one of the variables, justifying their choice. Column 3 describes where each variable is found or how it was calculated. And finally, column 4 contains the signs of the coefficients that we expect to find in our regression.

Control variable	Description	Proxy for control variable	Expected sign
Use of derivatives	The sample was separated into two groups of companies: those using derivatives financial instruments for hedging purpose and those that don't. (Doherty, 2005; Shimpi, 2002)	Dummy derivatives: 1 is used, 0 c.c.	Negative
Leverage	Theory shows that more leveraged companies take on more financing via debt, which has a cheaper cost than own capital. (Tufano, 1996)	We will verify the quarterly variation of the *D/V* relationship and the cost of capital found.	Negative
Size	In theory, the bigger the company, the lower the risk, and consequently its cost. (Perobelli and Fama, 2003; Serafini and Sheng, 2011)	It will be calculated by the logarithm of the total asset.	Negative
Profitability	A more profitable company tends to have a lower cost of capital. (Brito et al., 2005; Tavares and Sheng, 2007)	Net revenue/total asset	Negative
Operational risk	The theory of the bankruptcy cost suggests that companies with more risk have access to more expensive loans. (Brito et al., 2005)	Net operating profit revenue/EBIT	Positive
Average debt maturity	The greater the average debt maturity, the greater the cost of capital. (Kiyokawa, 2010)	Weighted average between short-term (1 year) and long-term debt (5 years).	Positive

Table 4
Output of the first test to verify influence of hedge on WACC.

Results obtained via the Eviews program for the proposed regression. The sample considered featured 26 periods – from 31 March 2004 to 30 June 2010 – totaling 877 observations. The independent variable considered was WACC, and the control variables were a dummy variable, the size and the leverage of each company.

Variable	Coefficient	(Std. Error)	p-value
Constant	0.211	(0.013)	0.0000
Dummy	0.011	(0.004)	0.0016
Size	−0.006	(0.001)	0.0000
Profitability	0.003	(0.002)	0.1695
Average maturity	0.000	(0.001)	0.8283
Operational risk	0.000	(0.000)	0.6670
Leverage	−0.096	(0.008)	0.0000
R-squared		0.2038	

of the *dummyh* variable (new name of control variable for using derivatives for hedging purpose). Unfortunately, none of the interactions was statistically significant at 5%.

Also with the aim of verifying a possible change of behavior, another test was performed including the *dummyt* variable in the final model of the previous test (shown in Table 5). Based on the results, which showed all the statistically significant variables for 5%, we can observe a negative relationship with companies' cost of capital from 2008 onwards, which could create signs of a change in companies' risk management policies. Table 6 shows the results obtained in the testing of this second hypothesis.

For a more in-depth analysis of the initial hypothesis, the methodology explained in Section 2 for calculating the TACC was used. The airline GOL was chosen for the tests since it had all the necessary data. Thus, it was compared the average WACC calculated by the simple model of Modigliani and Miller (1963) for this company (11.5%) with the results obtained via the Shimpi model, the TACC. Table 7 below shows the results obtained in this verification process.

These results suggests that, for airline GOL, the correct use of derivatives leads to a decline in the company's cost of capital, which would not reject the initial hypothesis. The empirical results herein obtained showed a difference in relation to the example presented by Doherty in his article: the order of grandeur of the difference between the conventional cost of capital and the TACC. Doherty found values of 15.9% for the WACC and 10.67% for the TACC (difference of −5.23%). In this example, the average variation was only 0.5%, also negative. As is well known, the volatility of this asset is high in Brazil, which triggers a high cost for the option. In other words, using market data for only this company, it suggests that the cost of risk capital isn't that low in the case of Brazilian currency risk vis-à-vis the US dollar, strengthening Shimpi's theory.

6. Conclusion

The financial crisis, which peaked in September 2008 with the bankruptcy of Lehman Brothers, showed that the effects of the use of derivatives can be highly detrimental to corporations. According to Farhi and

Table 5
Output of first test for verifying influence of hedge on WACC.

Final result obtained via Eviews programs, in which the Profitability, Average Maturity and Operational Risk variables that were not statistically significant were removed from the original model.

Variable	Coefficient	Std. Error	p-value
Constant	0.217	(0.014)	0.0000
Dummy	0.012	(0.004)	0.0009
Size	−0.006	(0.001)	0.0000
Leverage	−0.097	(0.008)	0.0000
R-squared		0.2040	

Table 6
Output of second test for verifying influence of hedge on WACC.

Results obtained via the Eviews program for the proposed regression. The sample considered was identical to that of the previous test. The independent variable considered was WACC, and the control variables were two dummy variables (dummyh and dummyt), the size and the leverage of each company — size of the sample and identical periods to the test demonstrated by Table 4.

Variable	Coefficient	Std. Error	p-value
Constant	0.193	(0.013)	0.0000
Dummyh	0.008	(0.004)	0.0185
Dummyt	−0.009	(0.001)	0.0000
Size	−0.004	(0.001)	0.0000
Leverage	−0.083	(0.008)	0.0000
R-squared		0.2423	

Borghi (2009), the negative effects may also be intensified in countries with more volatile currency markets, such as Brazil, Mexico, China, India and South Korea — emerging markets. The main objective of this piece was to study the influence of the use of currency derivatives on companies' cost of capital, based on data collected from non-financial, publicly traded Brazilian companies. The hypothesis was that the use of hedge reduces the cost of capital of these companies. It was used as a basis the studies developed by Modigliani and Miller (1963), Shimpi (2002) and Doherty (2005) for the necessary calculations, and for the estimation we used the Data Panel (cross-section with random effects) model.

The initial test results rejected the hypothesis due to the positive sign of the dummy variable coefficient, although they were not completely contrary to our expectations because, as became apparent after the events that took place during the 2008 financial crisis, companies were not using derivatives purely for protection, which would be the correct usage, but for speculative purposes also, confirming the studies of Tufano (1996) and Farhi and Borghi (2009). This affirmation can also be proven by verifying the test result of the second hypothesis: that the attitude of the management teams of large corporations has changed after the crisis. It was inserted a second dummyt variable to separate the data before and after 2008, and as a result, it was found a negative relationship between this variable and the variable explained – namely, that the regression signals a lower cost of capital for companies after 2008. A possible explanation could be that companies adopted greater caution in their hedging operations, while falling under greater scrutiny of regulators and even investors.

Furthermore, in the analysis via the TACC model, it was possible to verify that the correct use of hedging instruments genuinely does free up capital for the company. This freeing-up of equity leads to a reduction in the company's cost of capital, since the freed-up capital the highest cost of the capital structure. Contrary to what Doherty stated, the empirical results show that the model proposed by Shimpi does not underestimate the company's cost of capital, which could lead to wrong decisions being taken, such as approval of value-destroying projects. The main justification lies in the cost of risk capital. While Doherty simulated the purchase of a random protection instrument, here it was used real market data to estimate the USD cost of options.

Table 7
Comparison table of TACC x WACC.

The table below shows the average values, from the various scenarios analyzed, obtained for the TACC of the Brazilian airline carrier GOL. For each of the VaR considered, we considered three instruments that could be used as hedge. Comparing with the average WACC of 11.5%, the second line shows the difference in this company's cost of capital due to the cost incurred in taking out said hedge.

Panel: Data comparing the results between TACC and WACC						
	VaR 95%			VaR 99%		
	ITM (%)	ATM (%)	OTM (%)	ITM (%)	ATM (%)	OTM (%)
TACC	11.3	11.1	10.9	11.2	10.9	10.7
Difference	−0.2	−0.4	−0.6	−0.3	−0.6	−0.7

In this piece, the overriding takeaway is criticism of the lack of data in the Brazilian market, mainly in terms of the level of disclosure of information in companies' balance sheets and explanatory notes, in terms of net FX exposure and the percentage of this exposure protected by risk management. In addition, no systematic procedure to register company information about dividend policy and credit rating also reduced the sample size. For future studies, we expect that with a greater number of periods, it will be possible to carry out a more in-depth analysis on the signs of change in companies' behavior in terms of using derivatives after the 2008 crisis, and if this change helped reduce the cost of capital. We also recommend verifying the availability of data for a greater number of companies, thereby enabling a more in-depth study of the TACC model proposed by Shimpi (2002).

Appendix A. k_e — the equity cost

The cost of equity (k_e) can be estimated through the CAPM, model proposed by Sharpe (1964) and Lintner (1965). According to this model, the expected return by the equity holders is limited to the systematic risk, and the return of any asset adjusted to risk can be estimated by the Security Market Line (SML) equation as follows:

$$E(k_e) = r_f + \beta * \left[E(r_m) - r_f\right], \text{ where :} \tag{A.1}$$

- $E(k_e)$ expected return for a specific equity, which represents the equity cost to equity holders;
- r_f risk free rate;
- $E(r_m)$ expected return for a market portfolio;
- β coefficient that explains the effect of market variation over a specific equity.

Since the equity returns present serial correlation, the method proposed by Scholes and Williams (1977) will be used to estimate the betas. This methodology consists of three regressions: (i) regression of $r_{j,t}$ against $r_{m,t}$; (ii) $r_{j,t}$ against $r_{m,t-1}$ and (iii) $r_{j,t}$ against $r_{m,t+1}$. The adjusted beta, which will be the final beta for each company, is geven by:

$$\beta_{\text{ajusted}} = \frac{\beta_0 + \beta_{+1} + \beta_{-1}}{1 + 2 * \text{correl}\left(r_{m,t}, r_{m,t-1}\right)}, \text{where :} \tag{A.2}$$

$r_{j,t}$ is the return for asset "j", at time "t"; $r_{m,t}$ is the return for the market, at time "t"; $r_{m,t-1}$ is the return for the market, at time "t-1"; $r_{m,t+1}$ is the return for the market, at time "t + 1;" β_0 is the estimated beta from regression (i); β_{+1} is the estimated beta from regression (ii); β_{-1} is the estimated beta from regression (iii).

The Model of Gordon, also known as discounted dividends model, will be used to calculate the market portfolio return. This procedure was also adopted by Minardi and Sanvicente (2003). The main point of the model is to capture occasional deviations in the investor's behavior, getting a forward looking return for the market. The return for an asset is then given by:

$$k = \frac{Div_1}{P_o} + g \tag{A.3}$$

$Div_1 = Div_0 * (1 + g)$, and "g" can be estimated through $g = (1 - payout) * ROE$, where:

- payout = dividend per equity divided by profit per equity;
- ROE = Return on Equity = liquid profit divided by equity.

The values of the Brazilian LFT — 252 days (Float Rate Brazilian Federal Bonds) were used as the risk-free rate.

Appendix B. k_d — cost of debt

Table B.1
Current market data — The *Yield to Maturity* applied at calculating k_d.

Relation *D/V*	Rating	YTM (2004)	YTM (2005)	YTM (2006)	YTM (2007)	YTM (2008)	YTM (2009)	YTM (2010)
0% to 10%	AAA	3.88%	4.80%	5.26%	4.56%	2.59%	2.89%	1.81%
11% to 30%	AA	3.93%	4.82%	5.29%	4.66%	3.67%	3.32%	1.88%
31% to 50%	A	4.12%	4.97%	5.42%	4.96%	4.96%	3.93%	2.45%
51% a 80%	BBB	4.51%	5.27%	5.61%	5.22%	6.15%	4.43%	2.98%
81% a 100%	BB	5.37%	6.33%	6.51%	7.15%	9.70%	6.54%	4.37%
101% a 150%	B	6.37%	7.53%	7.22%	7.22%	12.10%	8.14%	5.69%

Table B.2
Brazil's risk premium used in addition to the YTM to calculate k_d.

Period	2010	2009	2008	2007	2006	2005	2004
EMBI — Bz	1.75%	1.92%	4.28%	2.21%	1.92%	3.11%	3.82%

Minardi and Sanvicente (2003) showed it is possible to estimate the k_d of a company with the utilization of market data, and the calculations below are based on that study. In the finance literature, there are reports about the possibility of minimizing the WACC by choosing the right relation "D/V" (Debt/Equity). The study by Minardi and Sanvicente (2003) shows what can be done, in current market conditions, to estimate this variable.

To determine the relationship between the cost of debt and the degree of indebtedness from the companies, there are two related occurrences:

- The credit rating agencies (Standard & Poor's, Moody's, Fitch) attribute a higher risk to the most indebted companies, which is contained in the literature since Pogue and Soldofsky (1969)[2];
- The fixed income securities of campanies with lower ratings are negotiated with higher discount rates (YTM).

Therefore, considering what was described above, Table B.1 shows the averages yields to maturity of the portfolios of corporate bonds issued by American companies, by level of credit risk.

Source: Own author, based on data provided by Bloomberg, Standard & Poor's, Moody's, Fitch.
The calculation of the companie's cost of debt will be done as follows:

- The "D/V" relation will be given by the quotient of the sum of short term debts with long term debts by the liquid patrimony of the companies;
- For each level of "D/V" will be assigned a correspondent level of rating,[3] according to Table B.1;
- Then, for each YTM determined will be added a risk premium for Brazil, considering the benchmark EMBI + Bz.[4]

Source: Bloomberg.

[2] They estimated linear models of probability considering four independent variables (indebtedness, profitability, profits instability and size of the company). As a result, Pogue and Soldofsky (1969) came to a positive and significant relationship between indebtedness and credit risk, that is, the higher the rating the lower the credit risk).
[3] For exemple, rating 'A' for the relation "D/E" between 31% and 50%.
[4] Minardi and Sanvicente (2003) used the C-Bond (brazilian debt title maturing in 2014), but this is no longer commonly used by the market. Therefore the EMBI (Emerging Market Bonds Index) will be used as it is considered the best indicator for this kind of risk premium.

Appendix C. Weighted Average Cost of Capital (WACC)

According to Brealey, Myers and Allen, a company's cost of capital is defined by the "projected return of a portfolio consisting of all shares of the company." Generally, this portfolio includes both the debt and the equity, and so the cost of capital is estimated by considering a compound of the cost of liability (represented by the interest rate) and the own capital cost (represented by the rate of return required by investors).

The equation below represents the estimation of this cost of capital, weighted by the distribution of the company's debt and capital:

$$WACC = k_e * \frac{E}{V} + k_d * (1 - T_c) * \frac{D}{V}, \quad \text{where} \tag{C.1}$$

- k_e cost of equity;
- k_d cost of debt;
- E Equity;
- D Debt;
- V Enterprise Value (E + D);
- T_c income tax.[5]

The calculations for ke and kd have been previously defined. These two variables as well as the ratio "D/V" will be earned for each end of the quarter according to the observed data and the equations shown in previous sections. The rate of income tax in Brazil (IRPJ) is 15%,[6] and added to the Social Contribution on Net Profits (CSLL) of 9%, gives a total of 24% in taxes.

By definition, the cost of debt can't be higher than the equity cost. Therefore, in some cases where it was, the cost of debt was considered for the equity cost from that company at that time.

References

Aysun, Uluc, Guldi, Melanie, 2011. Exchange rate exposure: a nonparametric approach. Emerging Markets Review 12, 321–337.
Black, Fisher, Scholes, Myron, 1973. The pricing of options and corporate liabilities. Journal of Political Economy 81 (3), 637–654.
Brito, G.A.S., Corrar, L.J., Batistella, F.D., 2005. Fatores determinantes da estrutura de capital das maiores empresas que atuam no Brasil. In: Conference paper presented in V Brazilian Society Anual Meeting (SBFin), São Paulo.
Chowdhry, Bhagwan, 1995. Corporate hedging of exchange when foreign currency cash flow is uncertain. Management Science 41 (4), 1083–1090.
Doherty, Neil A., 2005. Risk management, risk capital and the cost of capital. Journal of Applied Corporate Finance 17 (3), 119–123.
Farhi, M., Borghi, R., 2009. Operações com derivativos financeiros das corporações de economias emergentes. Estudos Avançados, IEA/USP 23 (66), 169–188.
Guttmann, R., 2008. Uma introdução ao capitalismo dirigido pelas finanças. Revista Novos Estudos CEBRAP 82, 11–33.
Harvey, C.R., 2000. The drivers of expected returns in international markets. Emerging Markets Quartely 4, 1–17.
Kim, Woochan, Sung, Taeyoon, 2005. What makes firms manage FX risk? Emerging Markets Review 6, 263–288.
Kiyokawa, F., 2010. Análise do Custo de Capital das empresas brasileiras de capital aberto, Insper, São Paulo/SP.
Lintner, John, 1965. The Valuation of Risk Assets and the Selection of Risk Investments in Stock Portfolios and Capital Budgets. Review of Economics and Statistics 47 (1), 13–37.
Merton, Robert C., 1993. Theory of risk capital in financial firms. Journal of Applied Corporate Finance 6 (3).
Minardi, A., Sanvicente, A.Z., 2003. A estimação do custo médio de capital de empresas sob processo de regulação econômica no Brasil. Encontro Brasileiro de Finanças, 3 (São Paulo/SP).
Minardi, A., Sanvicente, A.Z., et al., 2007. Estimação do custo de capital de terceiros a valor de mercado para companhias fechadas no Brasil visando uma melhor gestão estratégica de projetos, Insper, São Paulo/SP.
Mishra, Dev R., O' Brien, Thomas, 2005. Risk and ex ante cost of equity estimates of emerging market firms. Emerging Markets Review 6, 107–120.
Modigliani, Franco, Miller, Merton H., 1958. The cost of capital, corporate finance and theory of investment. American Economic Review 48 (3), 261–297.

[5] Modigliani and Miller (1963) conducted a new publication that will complement their previous work by adding the premise that the perfect market, in reality, does not apply, since the interest payments are deductible for purposes of calculating the tax Income. This deduction generates an additional cash flow, called the Tax Shield.

[6] Besides this 15% tax rate for the IRPJ, there is also an additional tax for profits higher than R$ 20.000,00 per month. For more details on the laws of the Income Tax in Brazil: www.receita.fazenda.gov.br.

Modigliani, Franco, Miller, Merton H., 1963. Corporate income taxes and the cost of capital: a correction. American Economic Review 53 (3), 433–443.
Perobelli, Fernanda, Fama, Rubens, 2003. Fatores determinantes da estrutura de capital para empresas latino-americanas. Revista de Administração Contemporânea (RAC) 7 (1), 09–35.
Pogue, T.F., Soldofsky, R.M., 1969. What's in a Bond Rating? Journal of Financial and Quantitative Analysis 4 (2), 201–2228.
Rossi, José Luiz, 2008. Does the use of derivatives add value to the firm? A study using Brazilian data. Revista de Administração de Empresas 48 (4).
Rossi, José Luiz, 2009. Corporate financial policies and the exchange rate regime: evidence from Brazil. Emerging Markets Review 10, 279–295.
Rossi, José Luiz, 2012. Understanding Brazilian Companies' foreign exchange exposure. Emerging Markets Review.
Schiozer, R.; Saito, R. 2007. Uso de derivativos em empresas listadas em Bolsas no Brasil, Revista de adminsitração da USP, v. 42, n1, pag. 97–107.
Scholes, M., Williams, J., 1977. Estimating betas from nonsynchronous data. Journal of Financial Economics 5 (3).
Serafini, Sheng, 2011. The use of foreign currency derivatives and the market value of brazilian companies listed at the Bovespa stock exchange. Revista de Administração Contemporanea (RAC) 15 (2), 283–303.
Sharpe, William F., 1964. Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk. Journal of Finance 19 (3), 425–442.
Shimpi, Prakash, 2002. Integrating risk management and capital management. Journal of Applied Corporate Finance. 14, 27–40.
Stulz, René M., 1996. Rethinking risk management. The Journal of Applied Corporate Finance 09 (3), 8–24.
Tavares, Sheng, 2007. Estimando a exposição cambial de empresas da BOVESPA. Braziliam Finance Society Meeting, São Paulo, Brazil.
Tufano, Peter, 1996. Who manages risk? An empirical examination of Risk Management practices in the gold mining industry. Journal of Finance 51 (4), 1097–1137.
Wooldrige, Jeffrey M., 2007. Introdução à Econometria: Uma abordagem moderna, 1ª ed. Tompson Learning, São Paulo.