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The Capital Asset Pricing Model – CAPM – the Special Case of Estimating Divisional Betas

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1. Introduction

The Capital Asset Pricing Model – CAPM is the most used method for estimating the cost of equity capital which in turn is a key element in project analysis and valuation.

The attractiveness of the CAPM lies on the relative simplicity of its principles and easiness of application. The model rests on the Modern Portfolio Theory, developed by Markowitz in 1952, which states that the diversification of an investment in various assets reduces the risk of the portfolio composed by such assets.

Based on the diversification concept, what really matters when an asset is valued is the marginal risk which the asset contributes to the risk of the portfolio.

Furthermore, the risk of an asset can be divided in the avoidable risk (non-systematic) and the unavoidable risk (systematic, market). While the former reflects the risk of a single company, which can be eliminated by diversification, the latter cannot be avoided by diversification, since it is affected by fluctuations in the economy as a whole.

In several surveys conducted in the United States[1], it was found that most companies use an institutionalized single cost of capital as the required rate for project acceptance. However, when projects are not homogeneous to risk, which is clearly the case in a multi-division firm, the use of a single discount rate for the entire company is not adequate. As a consequence, this criterion will reject projects with lower returns, even when compatible with their risk, and accept projects with higher returns, without taking into account their risk in a proper manner. This selection procedure will be biased towards high returns projects, increasing (disproportionally) the risk profile of the company.

Although there is widespread use of the CAPM by financial analysts and corporate managers in more developed countries, the application of the Model to emerging markets requires adjustment, since the strong assumptions related to market efficiency do not hold well. Even greater adaptations to the CAPM are necessary for

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[1]Alves (2002)

estimating the cost of capital for a company not listed in the stock market or for a division within a company.

The main focus of the current research project will be the estimation of divisional betas in order to evaluate projects or companies according to their risk.

Besides the introduction, this paper is structured in five chapters. Chapter 2 shows a brief description of the procedure for granting new concessions for undertakings in power generation and transmission in the Brazilian electricity industry. That chapter also describes the activities of Eletrobras (a multi-division power group in Brazil) and the study it contracted from a consultancy to improve its capital budgeting process. This information is relevant and is the background for the discussions on valuation and the CAPM throughout this paper.

Chapter 3 reviews the main concepts in project analysis and valuation. It will be shown that fundamentally there is no difference in evaluating a capital project or a stock, a security or an entire company. The methods of valuation will be described with focus on the Discounted Cash Flow (DCF) models.

Chapter 4 reviews the fundamental concepts of the CAPM, its application, limitations and extensions of the Model. That chapter indicates that the CAPM is the most accepted and widely used model for estimating the cost of equity capital, or, which is the same, the required return by investors.

Chapter 5 shows how the CAPM needs adjustment when applied to a multi-divisional company where projects have different risk profiles. It will be described how alternative methods can be used for estimating divisional betas.

The conclusion, in Chapter 6, summarizes the main issues discussed throughout the paper and makes recommendations on how the Model should be applied to a multi-division group in the electricity industry in Brazil.

2. Eletrobras and the Brazilian Electricity Industry

In order to set the context to which most of the discussion in this paper refers, let us present a brief description of Eletrobras and the Brazilian electricity industry.

Eletrobras is a state-owned company, listed in the stock exchanges of São Paulo, New York and Madrid. The Federal Government holds 58% of common stock.

The Eletrobras Group is composed of four generation and transmission companies, two thermal generation and six distribution companies. Eletrobras also controls 50% of the Itaipu hydroelectric power plant and has a minority stake in several other electricity companies. Thus, Eletrobras is definitely a multi-division group in the electricity industry.

Total Revenues of the Group was R$31,451 million (US$17,473 million), in 2008, and total Net Earnings was R$ 6,136 million (US$3,409 million), in the same year.

The installed capacity of the Group, as of December 31, 2008, was 39,402 MW, representing 38% of Brazilian installed capacity. The Group transmission assets in high and ultra-high voltage lines were 52,537 Km (60%) at the same date.[2]

The Brazilian Legislation and the Regulatory Model of the Electricity Industry require that every new undertaking in power generation and in high voltage transmission lines are objet of concessions granted to the concessionaires through a competitive bidding process.

This competitive bidding is conducted through an auction. The functioning of the auction is as follows: the Federal Government, through the Ministry of Mines and Energy and the Energy Research Company (100% state-owned), sets the ceiling price for the energy to be produced by a power plant or for the annual revenue in the case of a power transmission line. Then, in closed envelops, bidders make their offer and the lowest price (or annual revenue) wins the auction. If the two lowest bids are less than 10% apart from each other, the two lowest price bidders continue the process until one of them gives up the dispute.

The process is very competitive and especially so when there are a reasonable number of contenders. The initial price ceiling cannot be set too low otherwise there will be no contenders. Positive expectations about the future growth of the Brazilian economy, the political and economic stability the country has achieved, as well as the transparency and stability of the rules concerning the energy concession

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[2] Eletrobras – 2008 Annual Report, at www.eletrobras.com, accessed in March 23, 2010

procedure, all of these combined have attracted several large economic groups, foreigner and Brazilian, of which Eletrobras is a major player.

The contenders are usually consortium of companies, since the investment for each undertaking is very large for a single company to participate alone. For example the two hydro power plants in the state of Rondônia – Santo Antônio and Jirau – which concessions were granted last year have capital budget estimates of around R$ 10 billion each. In addition, the transmission lines for the power generated by these two plants have also a total budget of close to R$ 10 billion.

The consortium then signs a concession contract with the National Regulatory Agency and, in most cases, the consortium constitutes a Special Purpose Company (SPC). The project will be funded, developed and operated as a Project Finance, more specifically, a Build, Own, Operate and Transfer - BOOT scheme. The transfer occurs at the end of the concession contract (35 years for hydro-generation and 30 years for thermal-generation and transmission). In either case, there may be an additional 20 years extension period. The transfer is realized by the net book value of assets.[3]

The regulatory model of the electricity industry ensures that the entire energy produced by a power plant is sold to a pool of distribution concessionaries. In this way, the risk of not finding buyers to the energy produced is eliminated. The same holds for the transmission lines.

The revenues of the sale is in reais (R$) and it is indexed to the Consumer Price Index (IPCA). In addition, all concessionaries of generation and transmission have access to financing from the national development bank (BNDES) at subsidized rates of interest. The leverage of such projects can be as high as 70 to 75% (debt over total assets), if the debt service coverage ratio is acceptable. The nominal interest rate includes the target inflation rate (IPCA). In this way, there is hardly any risk that revenues and debt service will vary differently.

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[3] The criterion for determining the transfer value is under discussion within the broader process of changes in Br-GAAP in accordance to the International Financial Reporting Standards - IFRS

Since the bidding process can be very competitive, it is important for the contenders to know exactly how low they can go on their bid in order to win the bid but at the same time to guarantee an adequate return to the project.

In this way, the contenders develop sophisticated and detailed cash flow models to determine the desired rate of return.

As it will be mentioned, throughout this paper, a key element for establishing the required rate of return (or acceptance or hurdle rate) is the rate used to discount the cash flows to present value.

In order to improve its capital budgeting process, Eletrobras contracted consulting services from a specialized center for economic studies about the electricity industry from a major Brazilian university.[4]

The study was centered on the application of the CAPM to estimate the rate which Eletrobras should use to discount the cash flows of each project. From the start, GESEL's and Eletrobras' teams agreed that there should be not only one rate, but several, in order to take into account the nature of the project (generation, transmission, or distribution) and whether the project was greenfield (object of an auction) or an existing plant, as in the case of an acquisition.

In order to estimate the required rate of return for each business segment, the study used the pure-play approach, which will be described in detail in Chapter 5.

For the difference between a greenfield and an existing asset, the study estimated the beta for construction developers to be used during the construction period of a power plant or a transmission line.

The present term project will make reference to the consulting study for Eletrobras, whenever relevant, as the GESEL' study.

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[4] Grupo de Estudos de Energia Elétrica – GESEL / Federal University of Rio de Janeiro – UFRJ.

3. Project Analysis and Valuation

3.1 The Conceptual Framework

3.1.1 The Time Value of Money

One of the most fundamental concepts in Financial Economics is the time value of money. It basically says that money is worth more now than later. This is the same as to say that $1 to be received a year from now is worth less than $1 received today. The $1 of today can be invested in, say, a savings account, which yields i% of interest per year. At the end of the year, $1 is worth $1*(1+i)$. Alternatively, $1 to be received a year from now is worth today $1/(1+i)$.

Extending the concept to multiple periods, we have that at the end of n years, the $1 invested today would be worth $1*(1+i)^n$; this is what we call compounding – the interest rate is applied not only to the principal but also to the interest incorporated in the principal (interest over interest). In the same way, $1 to be received n years ahead would be worth today $1/(1+i)^n$, which is called discounting.

3.1.2 The Discount Rate

Understood what discounting is, we face one of most difficult problems in Finance Theory, which is to determine what the discount rate that should be used to bring future cash flows to their present value.

The discount rate has to do with opportunity cost; that is, the rate of return you could get in the next best alternative, with similar risk, to the project being considered. The word risk, in the previous sentence, is of fundamental importance for choosing the discount rate, as well as for many more applications in Finance; this concept will be developed in this and the following chapters.

For the moment, these introductory remarks about the discount rate are sufficient for the discussion which follows.

3.2 Project Analysis

Traditional project analysis can be summarized by the calculation of a few metrics of return, which the most common are the Net Present Value (NPV), the Internal Rate of Return (IRR), the payback period and a few other variations such as the

cost-benefit analysis (or profitability ratio), which is just another way to express the NPV.

The payback period is only mentioned here for the purpose of completion and because it is widely used by corporate managers when evaluating projects, but is clearly inferior to the others.

It consists solely of calculating in how many periods (month, year) the project will pay back the money invested in it, without taking into consideration the time value of money and the cash flows after the payback period. Adjustments can be made to its calculation to solve the first problem but not for the latter.

The two most widely used metrics are the IRR and the NPV. Although there is general consensus about the superiority of the NPV in relation to the all other methods, the IRR is preferable to many because it yields a rate in percentage, which can be easily comparable to the acceptance rate of return.

The basic drawbacks of the IRR are the following: (1) it has implicitly in its calculation that the returns of each period are re-invested at the same IRR. In some cases, when there is a wide difference between the IRR and the market rate, the IRR may yield a biased (upwards or downwards) rate of return; (2) other difficulty with the IRR is that when cash flows change sign more than once, there is likely to be more than one solution to the IRR and when that happens, none of the solutions will be accurate; and (3) the scale of investment, which is important when comparing two mutually exclusive projects; this is not necessarily a drawback of the IRR, but the NPV may be more appropriate as a capital budget decision. This is so because the IRR is expressed in percentage terms and, consequently, it does not take into account the scale of the initial investment. For instance, a project of $500, with a IRR of 25% and NPV of $68.18 will create more value than a project of $100 with a IRR of 50% and NPV of $36.36.

3.3 Valuation

Conceptually, there is no difference in project analysis and valuation. The former is, in general, applied to a particular project within a firm, while the latter is used to attribute value to any asset, usually, a stock or a company. But the fundamentals are

the same. Considerations about the debt-equity relationship in the valuation of a firm may also be taken into account in a specific project analysis within a firm.

In general terms, there are three methods of valuation: Relative Valuation, Real Options Valuation and Discounted Cash Flow (DCF).

Relative Valuation is used mostly to estimate the value of a company not listed or to assess how does the price of a stock compares to the one of a similar company. It consists of comparing ratios such as the P/E (price of a share divided by the earnings per share), Earnings/Ebitda, Earnings/Sales, and the like. Once we identified a similar company to the one we intend to valuate (the target), and choose one ratio, say P/E, we can calculate the price per share of the target company by multiplying the P/E of the similar firm by the earnings per share of the target and arrive at its price per share.

The method of Real Options is basically a DCF applied to specific projects or firms which have a real option embedded in them during a time period. The term real is used to differentiate from traded financial options. Examples of real options are: to abandon, to modify scale of operations, to alter the mix of inputs, and to expand.[5]

What is important to point out about the Real Options Valuation is that in specific situations where there are options embedded, the decision may be different than that of the DCF method which do not take into account the existence of real options. However, considerations about real options are beyond the scope of this paper.

This study will treat only the DCF method, by far the most used by fund sponsors, analysts and corporate managers to estimate the value of an asset.

There is widespread consensus in the Financial Economics literature that a project, or any type of asset, possesses value only by the cash flows it can generate. Be it a physical capital project, a real state property, a bond, a stock or an entire company, the most common and accepted methodology to determine its value is its future cash flow discounted to the present value by the appropriate rate.

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[5]Higgins (2009)

The two basic elements necessary to conduct the Discounted Cash Flow (DCF) analysis is to (1) forecast the future cash flows and (2) to determine what the appropriate discount rate is; the latter is the main object of this study.

3.3.1 The Discounted Cash Flow

3.3.1.1 Forecasting future cash flows

Although, the Discounted Cash Flow (DCF) methodology is considered conceptually sound, its application presents some difficulties which will be discussed in this and the next sections.

The first difficulty is to forecast future cash flows. The DCF methodology can be considered reliable only when the forecasted cash flows have a reasonable degree of certainty. When there are uncertainties regarding important variables, such as revenues growth, cost, prices, a sensitivity analysis – scenarios, stress tests, conservative forecasts – can be made to provide more information regarding the possible outcomes. However, some level of accuracy is required.

The quality of the forecasts involves a high degree of knowledge about the project being evaluated or about the industry or the company evaluated. For instance, for a high-growth company, there is the expectation of high-growth sales and profits, while in a consolidated industry the growth in sales is more modest. In addition, there must be an assessment of the length of time in which a high-growth company will become mature.

As mentioned in Chapter 1, in this study, whenever relevant, we will make reference to projects in the Brazilian electricity industry. In such projects, there is high degree of certainty in the future cash flows since quantity and price of the energy sold by the company which has the concession of the power plant (or transmission line) are established in the concession contract. The uncertainty lies in estimating the value of the capital budget, which often times is much smaller than the ex-post actual capital expenditure. Since price and quantity are fixed in contract, cost overruns in the capital budget can reduce or even destroy the attractiveness of such projects.

The cash flows to be forecasted are different from the accounting figures, such as net income, since the income statement contains elements that do not represent cash inflows or outflows (such as depreciation) or only partially (such as receivables,

payables) and it does not include cash flows such as capital expenditures, debt issues and debt payment. In other words, earnings reflect only the Income Statement, while cash flows incorporate also elements of the Balance Sheet. In order to forecast future cash flows, the starting point should be the Income Statement, but it needs to be adjusted for the non cash elements and for the items not included in the Income Statement. In fact, firms invest cash in order to receive cash returns in the future and only cash receipts can be re-invested in the firm or paid out as dividends. The superiority of cash flows over accounting profits is widely accepted and is related also to the concept of time value of money, discussed above.

There are two complementary alternatives for the valuation of a company (or project) by the DCF Model. One that considers the value of the company associated only to the equity capital (section 3.3.1.3 below) and the value of the company as a whole, which includes not only the equity of the stockholders, but also the debt owed to lenders, which we examine in the following section.

3.3.1.2 Free Cash Flow to the Firm (FCFF)

From the Income Statement we make the necessary adjustments to obtain the Free Cash Flow to the Firm (FCFF), as follows;

> Earnings before Interest and Taxes (EBIT)
>
> (-) Notional Taxes
>
> (=) Net Operating Income after Taxes (NOPAT)
>
> (+) Depreciation
>
> (-) Capital Expenditure (CAPEX)
>
> (-) Change in non-cash Working Capital
>
> (=) Free Cash Flow to the Firm (FCFF)

Note that the tax on earnings, referred to as notional taxes, is the actual tax rate which does not take into account the tax shelter of interest expense on debt. As it will be shown later, the appropriate discount rate the (the Weighted Average Cost of Capital (WACC) will consider the tax shelter.[6]

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[6] See DIXON (2000) p. 92 for this point.

3.3.1.3 Free Cash Flow to Equity (FCFE)

To obtain the FCFE we make the same adjustments to the Income Statement, as in the case of the FCFF, but this time we have to take into account the payment of debt to the lenders and then we arrive at the FCFE, as follows:

Earnings before Interest and Taxes (EBIT)

(-) Interest Payments

(=) Earnings before Taxes

(-) Taxes

(=) Net Income

(+) Depreciation

(-) Capital Expenditure (CAPEX)

(-) Change in non-cash Working Capital

(+) New Issued Debt

(-) Debt repayments

(=) Free Cash Flow to Equity (FCFE)

The appropriate discount rate in the case of the FCFE is what is called the cost of equity capital, which will be developed in greater detail in Chapter 4.

The results obtained by the DCF in both alternatives – FCFF and FCFE – should be the same if the two cash flows are specified correctly and if the appropriate discount rates are used in each case. Once the value of a company is determined by the FCFF, the value of the equity capital can be obtained by subtracting debt. If, on the other hand, the value of equity capital is calculated, or just quoted from the market (market capitalization), we add debt to obtain the value of the firm.

Some will prefer the use of the flow of dividends instead of the FCFE as the fundamental variable for valuing a company. In principle, there should not be significant difference between the two, since the FCFE is net of capital expenditures for new projects and, consequently, there is no reason for additional retained earnings and the available funds for distribution should be paid out in dividends. However, in some cases there may be significant difference between the two.

For some reason, management may decide not to distribute all FCFE as dividends. It may choose to leave some cash for an eventual need, which may or may not occur.

For instance, consider a Specific Purpose Company (SPC) which has the concession of a transmission line; project and firm are the same in this case. Since this type of project is highly leveraged, in turn of 70% (debt over total assets), in the first few years, funds are used mostly to pay debt and consequently the payout ratio is low[7]. Once debt is amortized, FCFE is higher than earnings and therefore dividends are less than FCFE. The SPC could buyback shares in order to transfer funds to stockholders but this would have to be taken into account when considering only dividends in the Model.

While many analysts have abandoned the dividend discount model, arguing that its focus on dividends is too narrow, some prefer it over the wider concept of FCFE, considering it a more conservative measure of the wealth of stockholders.

Damodaran (2003a) summarizes the discussion as follows

"While stockholders may not have a direct claim on the cash balances, they do own a share of these cash balances and their equity values should reflect them. In the dividend discount model, we essentially abandon equity claims on cash balances and undervalue companies with large and increasing cash balances. At the other end of the spectrum, there are also firms which pay far more in dividends than they have available in cash flows, often funding the difference with new debt or equity issues."

3.3.1.4 Terminal Value
In general, projects have a useful life of, say 10 to 15 years; at the end of such period, assets have a value of liquidation or recovery which should be discounted to Present Value in a project analysis.

In the case of valuation of a firm, there is a going concern assumption that firms have an indefinitely long life expectancy. In order to solve this practical problem, we can have a finite number of periods but in a way that it is equivalent to a perpetuity (or Terminal Value).

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[7] In some cases, contracts covenants do not allow dividends to be paid at all for some period

The way this calculation is done is as follows: we make projections of cash flows of, say, 5 to 15 years, assuming that at the end of the period the firm has reached maturity, that is, it has become stable, a low-growth business.

As an example, let us say that we made projections for 10 years and that after that the free cash flow will grow at 2% annually forever.

Thus, it can be shown, that in the 10th year we have:

CF_{10} + Terminal Value (TV)

where:

CF_{10} = cash flow of 10th year;

$TV = [CF_{10} * (1+g)] / (DR - g)$

DR = the discount rate

g = the stable rate of growth

Note that the growth rate (g) could be equal to zero, in the case of no growth. Note further that the entire value CF_{10} + TV must be discounted to present value. The latter observation implies that the higher the discounted rate used, the less important is the TV, other things being equal.

It is important to establish in which period the firm will achieve its mature stage. This may be difficult to estimate for high tech companies that have been showing extremely growth rates in the recent past. It is a difficult task and one that can only be done with an in-depth knowledge of the industry or the firm being valuated.

For the Brazilian electricity industry, this problem is easily solved, since the projection period, the energy sold and its price are all defined in contract.

In fact, things are not as simple as this. In some generation projects, it is established in the concession contract that, say 70% of the energy will be sold to distributers, at the auction bid price, and the other 30% will be sold to the free market (large industrial consumers) at the price negotiated among the parties. So, there is some uncertainty related to what prices will be in this case.

Another issue is that the contract of 35 years for hydro generation (30 years for transmission) can be renewed for another 20 years. In fact, the expectation is that it

will be renewed. However, project managers prefer to have a more conservative approach and consider only the first period.

The next chapter describes and analyses the CAPM as an estimator of the required rate of return by investors, or, which is the same, the cost of equity capital.

4. The Capital Asset Pricing Model (CAPM)

The model was introduced by William Sharpe (1964), John Lintner (1965) and Jan Mossin (1966), and Black (1972)[8] independently, building on the earlier work of Harry Markowitz on diversification and modern portfolio theory.

The Model was originally developed with the objective of stock pricing and extended to corporate finance applications, particularly those dealing with capital budgeting.

4.1 The Conceptual Framework

Before introducing the CAPM, it is necessary to explore a few concepts which are the foundation of the theoretical framework for the CAPM. The first one is the risk-return tradeoff. The basic concept is very simple and intuitive: an investor requires a greater return for investing in a more risky asset. Implicit in this concept is the notion that investors are risk-averse and must be compensated for taking additional risk.

The second concept is diversification. It means that the returns on assets in a portfolio are not perfectly correlated; that is, they vary in different magnitudes and, in some cases, in different direction (negative correlation), which makes the portfolio as a whole less risky than a particular stock. This is called unsystematic risk (avoidable or diversifiable).

Empirical studies point out that a portfolio of about 20 to 30 stocks, randomly selected, eliminates the unsystematic risk almost entirely. Additional expansion of the portfolio will not reduce the residual unsystematic risk any further. Based on the

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[8] Sharpe, F, "Capital Asset Prices: a Theory of Market Equilibrium under Conditions of Risk", *Journal of Finance* 19, (1964), Lintner, J., "The Valuation of Risk Assets and the Selection of Risk Investments in Stock Portfolios and Capital Budgets, *Review of Economics and Statistics*, 47 (1965) and Black, F., "Capital Market Equilibrium with Restricted Borrowing", *Journal of Business* (July 1992), APUD Costa Jr. et al (2000)

Portfolio Theory, investors need not be concerned with the unsystematic risk, since they can just diversify it away by constructing a portfolio of assets.

There is, however, a risk that cannot be diversified; this is called systematic risk (market or unavoidable or nondiversifiable). It is the risk intrinsic to a particular asset and cannot be diversified away because it is caused by factors that affect the entire economy, and, consequently, the entire market.

The CAPM assumes that all unsystematic risk has been diversified and, consequently, the important risk of a stock is its systematic (market) risk. In other words, the premium paid for a riskier asset refers only to the systematic risk and not to the total risk of the asset.

4.2 The Model

As introduced in Chapter 3, the most appropriate rates to discount each cash flow - the Free Cash Flows to the Firm (FCFF) and the Free Cash Flow to Equity (FCFE) – are the Weighted Average Cost of Capital (WACC) and the Cost of Equity (K_e), respectively. In this chapter we focus on the most accepted and widely used method for estimating the K_e , namely, the Capital Asset Pricing Model (CAPM).

The Model has achieved widespread use by major investment advisors and pension plan sponsors because it is simple in concept and has real world applicability. However, the popularity of the Model with corporate financial managers is still somewhat limited, although it is growing.

In order to present formally the CAPM let us return to the trade-off risk-return concept.

When investors buy a particular stock, they require a premium above a risk-free investment, say a Treasury security, otherwise they would not take the additional risk. The CAPM estimates a measure of the risk associated to a particular stock by relating the return of the stock in excess of the return of the risk-free investment to the return of the market portfolio in excess of the return of the same risk-free investment. This relation, measured by the beta, is showed by the equation below:

It should be noted that the expected return of a specific asset is the same as the cost of equity capital (K_e), that is, a market oriented return required by investors to allocate capital in any investment.

$$E(R_i) = R_f + \beta i * (E(R_m) - R_f)$$

where:

$E(R_i)$ – expected (or required) return of a particular asset i;

R_f = risk-free rate;

βi = Beta coefficient of asset i in relation to the market m;

$[E(R_m) - R_f]$ = expected risk premium of the market portfolio.

In the specification presented, as well as in the analysis that follows, we are using the terms asset, security or stocks, interchangeably, although they may have specific different meanings.

The model is based on the assumptions that the typical investor has a diversified portfolio and that the volatility of the returns is the appropriate measure of the risk and also that only the portion of this volatility which is systematic (non diversifiable) should be priced through a premium return.

The estimation of the required return of a particular stock and of the beta, in general, is done through a time series linear regression of the weekly returns of an asset listed in the market against the returns of the market, usually, for a period of two years. The beta is the slope of the above equation and measures the sensitivity of the return of a specific asset to that of the market.

We can solve the equation for beta, and rewrite it as follows:

$$\beta i = COV\ (i,m)\ /\ VAR\ (m)$$

where:

COV (i,m) is the covariance between possible returns for security i and the market portfolio; and

VAR (m) is the variance of the probability distribution of possible returns for the market portfolio.

A value of 1 for beta implies that the asset has similar risk to the market. A value inferior to 1 for beta means the return of the asset is less sensible to economic fluctuations than the market (defensive investment). When a beta is higher than 1, it means that the return of the asset is more sensitive than the return of the market to the cycles of the economy (aggressive investment).

The R^2 of the regression equation measures the proportion of total risk that has been explained by the relation of the return of an asset to the return of the market portfolio. A R^2 of, say, 25%, means that 25% of the total risk of the particular stock has been explained by the beta, which is the systematic risk, while 75% of the total risk has not been explained by the beta, this is the unsystematic risk.

As the number of stocks in the portfolio grows, through diversification, the unsystematic risk will be eliminated, or greatly reduced, and this will be reflected in a much higher R^2. Suppose this diversification is done by adding stocks to a portfolio in which the weighted average of their betas is the same as of beta the original stock. The beta of the portfolio will remain the same as the beta of the stock, but the proportion of total risk, which represents the non-systematic risk, will be virtually eliminated (high R^2).

The other parameters utilized by the Model are the risk-free rate (Rf) and the risk premium of the market portfolio [(E(Rm) – Rf]. The risk-free rate represents the minimum expected return by an investor in a risk-free investment. Usually, the risk-free rate adopted is that of sovereign securities of developed economies. Its characteristics of defined value and maturity of redemption, low probability that inflation will be significantly different than the one already incorporated by the nominal rate, and above all, very low probability of default by the governments of these nations make it a good proxy for a risk-free investment.

The risk premium of the market portfolio is the premium that investors charge for investing in riskier assets than government securities such as stocks. This required premium is a consequence of the risk aversion of investor to uncertain outcomes. Usually, analysts utilize historical averages of the premiums (return of a broad market index, such as the S&P-500, and the risk-free return) in order to estimate the market risk premium.
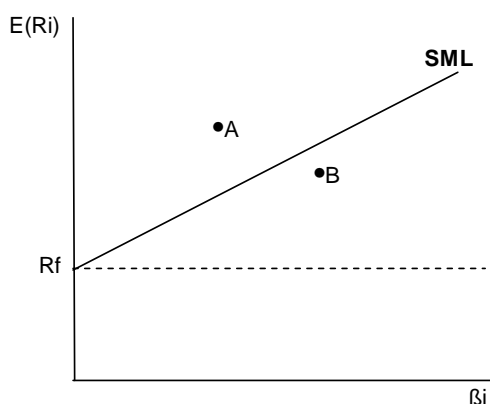
An alternative to estimate the beta through the historical return of a particular asset is to use the industry beta. This alternative is used when there are reasons to believe that the computation of the beta of an industry, which may include a number of listed companies, is more reliable than that of a particular company. This proxy for the beta is used also when a specific firm is not public but has similar characteristics to other listed firms. This issue will be explored in more detail later in this chapter and in the next.

Van Horne (2006) suggests that the use of historical data for estimating beta is backward looking and implicitly assumes that the relation will be the same in the future. Instead, we could make use of estimates from security analysts of the likely return of a particular stock conditional to the market return. This would be a forward looking approach. The problem with this alternative may be that the availability of information is inferior to that contained in the historical data.

4.3 The Security Market Line (SML)

In market equilibrium, the expected return of a security - $E(Ri)$ - and the systematic risk (βi) have a linear relationship which is known as the Security Market Line (SML). Under the assumptions of the CAPM, every security lies on the SML.

We can illustrate the concept by the diagram that follows:

If a security has a return in excess of the SML for the same level of systematic risk, such as point A in the diagram, investors will purchase that security and consequently its price will rise and return will fall, pushing point A back to the

SML. The reverse will happen for points below the SML such as point B in the diagram.

With the assumption of the CAPM of the Market Efficiency Hypothesis (discussed below on section 4.5), the adjustment would be automatic, there would not be lags. In the real world, the points in the diagram are moving towards equilibrium, but with considerable lag which permits investors to earn returns in excess of the expected return for the risk level of the security.

However, it is important to point out that the market for capital goods projects has a much slower adjustment mechanism than financial markets. The implication of this time lag is that managers can create value to stockholders selecting and approving capital projects within the firm that are above the SML.

On the other hand, projects which lie on the SML will not be creating any excess value to stockholders, since they can invest, instead, in other stocks which lie on the line.

Moreover, it is not a task to management to diversify the activities of a company with the sole objective of diversification. This the stockholders can do themselves even more efficiently.

4.4 Important aspects of the CAPM

4.4.1 Maturity of risk free security

While there is widespread agreement about using the Treasury security as the risk-free investment, its maturity is a point of divergence. Some propose a short-term rate, such as the T-bill (3 months), because the CAPM is a one-period model. Others suggest that the maturity should be that of a long-term T-bond, in order to reflect the long maturity of capital investment. There are others yet who recommend an intermediate maturity, that of a medium-term T-bond, between 3 to 5 years, under the argument that most capital investment lie in this range of maturity.

From this discussion, it seems reasonable to adopt the maturity according to the underlying capital investment. For the Brazilian electricity industry, projects of generation and transmission have a maturity of 30 years; therefore, a T-bond of 30 years would seem appropriate.

The definition of the maturity is important because there is significant difference in rates according to the maturity of the Treasury security being considered and because the selection affects market premium. For instance, as of 04/14/2010, the US Treasury yields at constant maturities are: 1-year (0.472%), 10-year (3.811%) and 30-year (4.671%).

Moreover, it can be shown that for betas less than 1, using a long term security (higher rate) will amplify the required return being estimated. On the other hand, if beta is greater than 1, the required rate will be reduced when a long term security is used as the risk-free rate.

4.4.2 Equity risk premium

The range of estimates for the equity risk premium, or market premium, is wide. Estimates by Ibbotson Associates computed for the period 1926-99, using arithmetic averages, are in the range of 7.4 to 9.5%, depending on the maturity of the security being considered. On the other hand, when geometric averages are used, the premium falls for 6.1 to 7.5%, again, depending on the maturity of the risk free investment. Most find that the geometric average is more appropriate to measure long run cumulative wealth changes.

Also, such a long period utilized by the Ibbotson Associates is considered not to be adequate in view of the events that have occurred during this time period – Great Depression, World War II – and the structural changes in the economy.

A recent survey with finance professors in the US and Europe, found that in 2008, the averaged market premium used in the US was 6.3% while in Europe was 5.3%.[9]

4.4.3 Market index

The "true" market portfolio consists of all assets in the economy – stocks, bonds, real state, human capital. The S&P-500, or any other index, fails to represent most of these assets and the consequence of this is that estimates based on an index may not be reliable.

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[9] Fernandez, P.: "The Equity Premium in 100 Textbooks", at www.ssrn.com/abstract=1473225 , accessed on 03/20/2010

Roll (1977) shows that there are significant variation in estimates whether one uses the S&P-500, the NYSE or other index. This reinforces the statement that the use of market indices has its shortcomings.

Other authors[10], however, consider that for most applications, a broad based index such as the S&P-500, is a reasonable proxy.

4.4.4 Fama-French critique

Empirical investigation by Fama and French (1992)[11] found that there are other factors determining returns besides beta. For instance, firms with small value of capitalization (small caps) show greater returns than high capitalization firms, holding beta constant. In addition, stocks with low P/E and market-to-book values show greater returns than stocks with higher ratios.

This implies that the beta may not be the only factor that explains returns of stocks and, in view of this critique and others, several extensions of the Model have been developed; they will be treated later on in this Chapter.

Van Horne (2006) acknowledges the limitations of the CAPM, but states that Fama and French focused on required returns and not on risk. In conclusion, the Model may not be very accurate for estimating required returns for a given company but it remains a good measure of risk. In his words: "*The CAPM trade-off between risk and return is a useful guide for approximating capital costs and thereby allocating capital to investments projects*".

4.5 Assumptions

The basic assumptions of the model are presented below and are based on the perfect competitive model in which the Market Efficiency Hypothesis (MEH) holds:

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[10] Rosemberg and Rudd (1986)

[11] Fama, E. and French, K., "The Cross-Section of Expected Returns", Journal of Finance, 47 (June 1992), APUD, Brealey and Myers (2006), p. 195.

- investors are risk averse and maximize their expected utility;

- investors are price takers and have homogeneous expectations in relation to returns and their distribution probabilities;

- there is a risk-free rate by which the investors can borrow or lend;

- there are no transaction costs, information is cost-free and available to all simultaneously; and

- there are no market imperfections such as taxes and regulation.

The MEH states that the market price of a security represents the market consensus estimate of the value of that security. In other words, a security price reflects all available information about the economy, the financial markets and the company.

Empirical evidence suggests that markets are reasonably efficient, in the sense, that although prices fluctuate around their fundamental value (randomly, according to the MEH), it is very difficult for a particular investor to practice arbitrage, that is, "to beat the market".

Paradoxally, there is a large number of investors who believe that the markets are not efficient and, consequently, these investors produce a large amount of analytical data about opportunities of gains in the market; this ends up being an important source of information and, thus, makes the market more efficient.

Next, we will examine the violation of one of the assumptions of the CAPM which may have significant implications on the applicability of the Model.

The assumption is related to transaction costs, more specifically, to the insolvency or bankruptcy cost. The Model assumes that if bankruptcy occurs, all assets will be sold at their economic value, which implies that workers, suppliers, debt holders and, finally, stockholders will receive their share of the business at the economic value.

However, this assumption is too strong; in the real world, there are frictions in the bankruptcy process and often is the case that there will be nothing left for the stockholders.

In Chapter 4, we discussed that it was not a task for the firm to diversify its activities with the objective of diversifying away this risk because the stockholders could do it themselves.

However, the risk of insolvency or bankruptcy is part of the total risk of a firm and cannot be diversified from the investor perspective. The increase in the perception of insolvency risk raises the cost of doing business. In this sense, it is not only the systematic risk that matters but the firm should pay attention to total risk. Stated differently, the firm will be creating value to investors through diversification. This conclusion has important implications in the application of the Model.

Van Horne (1980) describes the application of the CAPM for estimating hurdle rates for a small high tech company. After calculating the required rate, the board of the company decided to add an additional 1.5% to the cost of equity capital (K_e) as a premium for the insolvency risk. Although, the value 1.5% is certainly subjective, the previous discussion suggests that it is a reasonable measure.

4.6 The Global CAPM

The globalization of the markets has induced analysts to adopt global parameters for the CAPM. The concept of global market implies that any investor is able to invest in assets anywhere in the world. In the Brazilian stock market this seems to be the case in view of the large number of foreign investors present in the São Paulo Stock Exchange (BOVESPA) and also by the increasing number of some Brazilian companies listed in the New York Stock Exchange.

The adjustment made to the CAPM to consider the globalized markets is called Global CAPM and utilizes, as proxy parameters for a global market, the return to the US Treasury securities as the risk free rate and the New York Stock Exchange as the reference for estimating the market premium.

Then, there is the question of whether there is a need for considering additional risk premium when evaluation equity in emerging markets. This is a matter of integration of markets. If markets are integrated, investors have a global diversified portfolio, while if markets are segmented, the diversification is not global.

As mentioned before, what we must have in mind is that the relevant risk for estimating the cost of equity is the systematic risk, or risk that cannot be diversified away. The important question is then whether the risk in emerging markets is diversifiable or non-diversifiable.

Damodaran (2003b) suggests that there are two conditions for the country risk not to matter. First, the investor has a globally diversified portfolio; second, all or most of the country risk should be country specific, in other words, there should be low correlation across markets.

While the empirical evidence of the 1970s and 1980s pointed to low correlation across markets, this correlation has increased significantly in the past two decades, which has been observed through the spread of financial crises among emerging markets in the late 1990s.

The conclusion of Damodaran's analysis is that although there has been increasing integration across markets, a risk premium should be considered when investing in emerging markets because: (1) markets continue to be partially segmented; and (2) the correlation across markets has increased significantly, making country risk not diversifiable.

The adjustment of the Model, shown by the equation below, consists of adding a Country Risk Premium (CRP) for investment in stocks in emerging markets.

$$E(R_i) = R_f + CRP + \beta i * (E(R_m) - R_f)$$

where:

$E(R_i)$ – expected (or required) return of a particular asset *i*;

R_f = US Treasury Security;

CRP = country risk premium;

βi = Beta coefficient index of asset *i* in relation to the market *m*;

$[E(R_m) - R_f]$ = US Risk Premium

In the GESEL's study developed for Eletrobras, the Global CAPM was used and the parameters utilized by the Model were the following:

R_f = US Treasury Bond – 30 years (4.48%);

CRP = EMBI-Br (2.82%) + CDS for corporate Br-AAA (0.5%);

$[E(R_m) - R_f]$ = US Risk Premium (5.65%)

> where:
>
> EMBI-Br is the Emerging Markets Bonus Index for Brazil, calculated by JP Morgan, as a measure of country risk; and
>
> CDS Br-AAA – is the Credit Default Spread for corporate risk with a AAA rating in the Brazilian market

4.7 Extensions of the Model

4.7.1 Multivariable approach

The critics of the CAPM, especially the already mentioned Fama-French critique, stated that the CAPM relies exclusively on one variable to explain the expected return of a security – the expected return of the market portfolio, being the beta coefficient the measure of such relation.

As discussed in the previous section, empirical tests showed that other variables such as the size, the P/E and the market-to-book ratios and others also add explanatory power to the Model.

There are two alternatives for the multivariable approach: the extended CAPM and the factor approach, of which the Arbitrage Pricing Theory (APT) has gained most notoriety.

4.7.1.1 The Extended CAPM

Extended CAPM means that additional variables are added to the original CAPM but the market premium remains, that is, the beta continues to be a parameter in the equation, as follows:

$E(R_i) = R_f + b * \beta i + c * f$

> where:
>
> $E(R_i)$ – expected (or required) return of a particular asset i;
>
> R_f - risk-free rate;
>
> βi – the security's beta
>
> b – coefficient indicating the relative importance of beta

f – factor representing additional variable included in the Model; and

c - coefficient indicating the relative importance of factor *f*

The factor *f* can be any variable which explains change in expected return, in additional to market portfolio. Candidates for the factor variable could be: dividends payout ratio, unexpected inflation, market capitalization size, P/E and market-to-book ratios.

Most of the empirical studies suggest that adding variables to the CAPM will increase the explanatory power of the Model. The Fama-French critique goes further in suggesting that the beta should be excluded from the Model.

4.7.1.2 The Arbitrage Pricing Theory (APT)

The concept behind the APT is that investors (or arbitragers) will seek price differentials for assets with the same expected cash flow and risk. By buying the under-priced stock and selling (or short-selling) the over-priced stock, investors will gain from arbitrage but this will push prices back to their fundamental values, thus eliminating the opportunities for arbitrage. The concept is included in the Market Efficiency Hypothesis (MEH), a fundamental assumption of the CAPM.

The APT does not specify which factor variables should be included in the Model. It only states that the expected return of an asset can be expressed by a number of factors and if the result of such equation is equal for two different securities, arbitrage will bring their market price and consequently their returns in line.

Roll-Ross (1980) developed a five-factor APT model in which the variables are the following: (1) changes in expected inflation, (2) unanticipated changes in inflation, (3) unanticipated changes in industrial production, (4) unanticipated changes in the yield differential between low and high-grade bonds (the default risk premium), and (5) unanticipated changes in the yield differential between long-term and short-term bonds (the term structure of interest rates).[12]

Empirical test for the APT has been inconclusive. In fact, there is no empirical evidence of the superiority of the APT over the CAPM, or vice-versa, although the

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[12]Van Horne (2006)

CAPM continues to be the widely accepted model by funds sponsors, financial analysts and corporate managers.

5. The CAPM as an estimator of divisional betas

According to several surveys, companies, in general, do not take into account the different risks associated with each division within the company. Brigham (1975) found that 62% of the firms surveyed use a sole discount rate to evaluate all project proposals; in similar survey, Bruner et al (1998) found this proportion to be 41%. Gitman and Mercurio (1982) found that between 30 and 50% of the firms do not make any adjustment to risk for different projects.[13]

The consequence of using the same required rate of return for all project proposals is that this criterion will reject projects with lower returns, even when compatible with their risk, and accept projects with higher returns, without taking into account their risk in a proper manner. This selection procedure will be biased towards high returns projects, increasing (disproportionally) the risk profile of the company.

So far, we have considered the estimation of beta and the cost of equity capital for a public traded company. We turn now attention to how to apply the CAPM for a firm not listed, or a division of a firm (or a capital project within a division). This is a practical problem of the Model and there is widespread consensus in the literature about the need to adjust the CAPM for this type of application.

5.1 Pure-play approach

The pure-play approach (or method of similars) consists of finding a company listed in the stock market which activity is the same as that of the division of a firm being valued. By calculating the beta of this pure-play company, the CAPM can be applied to estimate the cost of equity of the division under analysis.

The concept of division here is not the same as the one of a company organization, but rather, a business segment (an industry). In the present study, there are two divisions: power generation and power transmission.

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[13]Alves (2002)

There is an implicit assumption that the projects within the division are homogeneous with respect to risk. In the present case, the object of each division is very defined and specific, although there may be differences in projects in power generation related to size and locality which make these projects somewhat different from each other with respect to their risk (the same holds for transmission lines). However, the approximation is reasonably good.

The second potential problem lies in finding a listed company which has the exact activity as the division under analysis. This is possible to find for the Brazilian power industry, where there are pure-play companies in generation, transmission and distribution of power. There are also companies which are multiple-play, that is, they perform more than one of these activities. In this latter case, such companies cannot be utilized by this approach directly.

The GESEL's study identified five pure generation companies, four distributers and only two transmission companies listed at the BOVESPA market.

Once the pure play companies have been identified, we can estimate the betas of the listed companies and use a measure of central tendency, such as the median, as a proxy for the beta of the division. The median, in general, is superior to the average because it eliminates the influence of outliers.

Since there were so few pure-play companies listed, (only two, in the case of transmission), the beta estimates may not be very accurate.

In Rosemberg and Rudd (1986), the authors suggest the expansion of the sample to an industrial segregation such as the Standard Industrial Classification (SIC) for the United States. However, the approach may have problems of its own, such as in the case of a project be related to more than one industry classification. Or the opposite may occur, such as using a classification too broad like "Electric Utilities" or "Energy", which will not be useful for the generation / transmission levels we need to estimate.

Another recommendation from the same study is that whenever estimates of beta are not very reliable, in order to predict future betas, the historical betas should be averaged out with the market beta (1.0) or with the industry beta. As an example, the

authors mention that "*Merrill Lynch uses weights of 0.66 on historical beta and 0.34 on the average value for their prediction of beta*" in its booklet entitled "Security Risk and Evaluation Service". (Value Line, an investment research firm, does a similar procedure for its <u>adjusted</u> beta.)

It should be mentioned that by estimates not very reliable, the authors do not refer only to the size of the sample, which would yield large standard errors, but also to the use of historical beta to predict future betas.

Another study[14] related to divisional betas, applied to the Brazilian market, made use of the pure-play approach utilizing industrial classifications. In that study, Eletrobras was considered a pure-play company for the electricity industry. For the purpose of the current study, this classification would be too broad.

5.2 Impact of Leverage

According to Brealey and Myers (1996), from the factors that affect the systematic risk of an asset (beta), there should be pointed out the business cycles and the financial leverage. The business cycle affects the beta of companies due the seasonality of revenues and earnings, while the leverage is related to the cost structure of a company, in the sense that a company with higher fixed costs (interest payments) in relation to its total costs has a higher systematic risk.

The beta that is estimated from market data is the leverage beta (β_L), that is, a beta which reflects the leverage of the listed company chosen.

When trying to identify pure-play listed companies for estimating divisional betas, one must take into consideration two aspects: (1) if the listed pure-play company has the same leverage as the company being valued; and (2) if the leverage of the division is the same as the multi-divisional group of which it is part of.

The second consideration we can assume to be a reasonable one, since the company, and not the division, is the ultimate responsible for its debt.

The first consideration, if adopted, would restrict even more the already limited number of listed pure-play companies. However, there is a procedure developed by

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[14]Alves (2002)

Hamada (1972)[15] by which it is possible to transform the leverage beta into an unleveraged beta (β_U), by using the following formula:

$$\beta_L = \beta_U / [(1+ (D / E) * (1 - t)]$$

where:

D = debt

E = equity

t = tax rate

After un-levering the pure-play company beta, we can lever it again to the capital structure of the company being valued.

5.3 Multiple-play approach

The multiple-play approach has the same concept of the multivariate approach, examined in Chapter 4, but in the present case it refers to divisional betas estimates.

Rosemberg and Rudd (1986) suggest that the estimates of divisional betas can become more accurate by introducing fundamental operating and financing characteristics of the company or the division. The argument is that the pure-play technique ignores a vast amount of useful information from diversified companies.

The results obtained by the authors show that the estimation of divisional betas by the multiple-play method performed better than when only market data was used, as in the pure-play approach. Furthermore, when combining fundamentals with historical betas the predictions have outperformed either method when applied separately.

The proposed method makes use of a complex econometric model in which accounting data, such as growth, earnings variability, financial leverage and size, are incorporated as explanatory variables to estimate returns of a company or division. In the case of individual projects, historical data from project returns can also be used.

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[15] Hamada, R., "The Effect of the Firm's Capital Structure on the Systematic Risk of Common Stocks", *Journal of Finance* (May 172), APUD, Ehrhardt and Bhagwat (1991)

In the case of Eletrobras, although the information of balance sheet, income statement and cash flow per division (generation and transmission) are not publicly available, the data does exist and can be used internally for contributing to the estimation procedure.

Ehrhardt and Bhagwat (1991) propose a similar method which they call "the full-information approach", relying on the concept that a firm is a portfolio of projects.

The methodology is based on the principle that betas are additive; that is, the beta for a company is simply the weighted average of the betas of each division, as shown by the following formula:

$$\beta i = \sum wij \times \beta j$$

where:

βi = the overall beta for firm i;

wij = the market value of division j for firm i.

βj = the estimate of beta for division j.

The method is a two-step process – in the first step, the betas of each company are estimated, while in the second, the divisional betas are predicted by the formula above.

The necessary data for the estimation of the divisional betas are market returns for the companies listed and market returns for the business segments; in the latter, the Standard Industrial Classification (SIC) in the four or two digits classification is used.

In addition to the difficulties of using the SIC classification, as mentioned above, there is the problem of data availability for the market value for each division (wij). As a proxy, the authors suggest the use accounting data, such as the ratio sales (or ebitda) of the division to sales (or ebitda) of the company. In their opinion, such ratios, in spite of having shortcomings, are better than the book values of assets of each division. Harris et al (1989) disagree with this point and prefer the use of book values because they represent a stock, which is a better measure of wealth, rather than a flow as in the case of sales. In my opinion, sales or ebtida are closer to market

values than book values of assets, which, in some cases, deviate substantially from market values. With the changes in the accounting principles, as Br-GAAP moves towards the International Financial Reporting Standards (IFRS), book value will become a more reliable measure since assets will be accounted at fair their value[16].

One other measure is the present value of the future cash flows of each division (when available).

Another advantage of using the multiple-play approach, when applicable, is that by not restricting the sample to pure-play companies the problem of sample size is eliminated and, consequently, the estimates can be more accurate.

Other authors have developed similar multiple-play approaches to the Ehrhardt and Bhagwat presented here. However, the differences lie in methodological (econometric) subtleties which are beyond the scope of the present research project. Nonetheless, it is important to mention other studies for possible future further investigation. Some of these are Kaplan and Peterson (1998), Harris, O'Brien and Wakeman (1989), Gup and Norwood III (1982), among others.

Some of these proposed methods, as is the case of the latter, rely heavily on management judgment for attributing different premiums to what is considered to be a riskier division. Although corporate knowledge is an important element, we should not rely on it excessively. If this were the case, we would be deviating from fundamentals.

6. Conclusions and Recommendations

As stated in the introductory chapter, the main objective of this research project was to review the specialized literature on the Capital Asset Pricing Model with one focus: how to estimate the cost of equity capital for projects or divisions within the Eletrobras Group, notably, the power generation and power transmission segments.

The review of the conceptual framework of valuation and of the CAPM indicated that although there are some limitations in the applicability of the CAPM, this model

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[16]Fair value, in most cases, is calculated by the DCF method.

is the most widely used method for valuing any type of asset and also for supporting capital budget decisions.

In this review, it was confirmed that the difficulties of the use of the CAPM are even greater when it is applied for companies not listed, or divisions and capital projects within a company.

The pure-play approach, which consists of identifying a listed company in the same line of business of the division being valued, is the most straightforward method. However, it is not easily implemented because of the difficulty of identifying such a listed company. Even when the match is acceptable, there may be very few firms which can make the estimates inaccurate.

The study developed for Eletrobras (the GESEL study) relied on the pure-play method. It was able to identify pure-play companies, in which the only businesses were power generation or power transmission. But, in the case of the latter, there were just two companies.

The other method for estimating divisional betas, examined in Chapter 5, was the multiple-play approach, which consists of including not only pure-play but also multiple-play companies in the sample of analysis. The reason for doing so is that the multiple-play firms bring additional information and also increase the sample size. The method, however, has problems of its own. It makes use of accounting data and relies on management judgment for filling in missing information.

We can conclude that the task of estimating divisional betas is not an easy one, since each approach presents shortcomings in its application. However, the alternative of not using the CAPM (or variations of it) is to rely solely on subjective decisions without a conceptual framework based on sound theory, yet with limitations in its application.

Thus, we can list a series of recommendations which could be incorporated in Eletrobras' capital budgeting process:

- Continue to make use of the CAPM for estimating the cost of equity capital of the multi-divisional group;

- Continue to apply the pure-play approach for estimating divisional betas, but in this case, there should be considered the observations and adjustments to the method, as follows:

  o The beta of the Group should be equal to the weighted average betas of each division;

  o Accounting data such as sales, ebitda, net income and other should be considered, since this data is available at the division level and should complement the market information of returns of stocks;

  o Consider averaging out the divisional betas estimated by the pure-play approach by the market index, in particular, the electricity industry index (IEE) of the BOVESPA market;

  o In the identification of pure-play companies listed, consider also investment funds that hold shares of specific segments;

  o Make use of expectational data from financial analysts;

  o Test different alternatives for the market premium – S&P-500 versus IBOVESPA to verify which generates the best estimates;

  o Concentrate in more practical approaches for dealing with the necessary adjustments, rather than invest in complex econometric models, which are more suited for scholar research than to the capital budgeting of a corporation;

  o Make use of the vast amount of data of returns of projects in power generation and transmission which Eletrobras has undertaken;

  o Finally, there should be kept in mind that whatever the value of required returns are obtained for each division, they should not diverge substantially from the public information produced by financial analysts.

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