Research and Development and Stock Prices of Brazilian Companies: An Empirical Study

Arildo Hungarato
Bachelor's in business administration with specialization in management accounting (Federal University of Espírito Santo - UFES)
Master's in accounting (Fucape Business School)
Professor at Faserra - IES Blauro Cardoso de Mattos
Rua José Luiz Gabeira, 170 - BL C – Apto 1302 - Barro Vermelho - Vitória (ES) – CEP: 29057.570
E-mail: arildoh@globo.com

Aridelmo José Campanharo Teixeira
PhD in control and accounting (USP)
Professor at Fucape Business School
Av. Fernando Ferrari, 1358, Boa Vista, Vitória (ES). CEP 29075-505
E-mail: aridelmo@fucape.br

Abstract

The aim of the present study is to identify the relationship between spending on research and development (R&D) and the stock price of Brazilian companies listed for trading on the São Paulo Stock Exchange (Bovespa), following on the studies of Lopes (2001;2002) and Rezende (2005) about the value-relevance of accounting information in Brazil. This empirical-analytic study was based on the model of Collins et al. (1997), which is a proxy for the Residual Income Valuation (RIV) model of Ohlson (1995), and on the classification of technological intensity in the study of Chan et al. (1990), carried out in the United States. The sample consisted of Brazilian firms with shares traded on the Bovespa between 1996 and 2006. By means of multiple regressions we identified that R&D spending is not statistically significant for the stock prices of the firms analyzed. These conclusions do not corroborate the findings of Chan et al. (1990), but do provide support for the studies of Ohlson (1995) and Lopes (2001; 2002) and complement the study by Rezende (2005), since our results indicate that earnings is statistically significant for stock price, with a positive relationship even after deducting R&D spending accounted for as expense. The situation is different for book value, which ceased being statistically significant and being related with stock price after deducting R&D spending accounted for as investment.

Keywords: Research and development; Stock price; Value-relevance; Bovespa;

Published in Portuguese, English and Spanish. Original Version in Portuguese.

1. INTRODUCTION

According to Ball and Brown (1968, p. 160), accountants must deal with consolidations, mergers, research and development and price-level changes, among other questions. Therefore accounting needs to have a comprehensive theoretical framework for the various different accounting practices. Several empirical studies conducted in the United States have tested the relationship between R&D spending and the increase in stock price of companies (CHAN et al., 1990; DAMODARAN, 1997; AMIR and LEV, 1996; COLLINS et al. 1997).

Based on the studies of Lopes (2001;2002) for the Brazilian market and on the model of Collins et al. (1997), which is a proxy for the RIV model of (1995), Rezende (2005) analyzed investments in intangible assets and their effects on the value-relevance of earnings, book value and deferred assets. He identified that investments in deferred assets are significant for the share prices of telecommunications firms in Brazil, although the explanatory power presented inverse results than expected in the research hypotheses.

1.1 Research Problem and Hypotheses

We seek to answer the following question: Does spending on R&D have a relationship with the stock price of Brazilian firms listed on the Bovespa, classified as high- and low-technology firms? With the aim of reinforcing the studies of Lopes (2001;2002) and complementing that of Rezende (2005) about the value-relevance of earnings, book value and deferred assets, and based on the classification of technological intensity of companies applied in the studies of Chan et al. (1990), IPEA (2004) and IBGE (2005), we formulated the following hypotheses:

H0a: R&D spending has a positive relationshhip with the stock price of high-technology companies listed on the Bovespa.

H0b: R&D spending has a negative relationshhip with the stock price of low-technology companies listed on the Bovespa.

We believe that the analysis of the results obtained from the data will contribute to expand the discussion of some controversial points, such as the position of companies for definition of their strategies of competing through innovation or costs.

1.2 Research Objectives

Our aim here is to identify whether the information on R&D spending dissclosed annually in the financial statements (balance sheet and complementary statements) has a relationship with the stock price of Bovespa-listed companies. To delineate the topics of interest, we formulated the following specific objectives: a) to summarize the results of previous studies on R&D, with focus on the accounting area; b) to identify and present the stages of the methods for classification of technological intensity existing in the literature; and c) to identify whether technological intensity affects the relevance of R&D spending on the stock prices of firms listed on the Bovespa.

Better knowledge of the relevance of R&D spending (classified as investments or expenses) for the stock price of firms will help business managers reach strategic decisions. In the area of government, it will help stimulate policymakers in the development of public policies in the R&D area.

2. TECHNOLOGICAL INNOVATION

According to Rothwell (1995, p. 2), over the previous 40 years, the perception of the dominant innovation model and innovative practices underwent several changes, identifiable by different generations of the innovation process: **a)** from 1950 to the mid-1960s, the dominant innovation model was

seen as driven by technology, that is, as a linear consequence of technology, so that more spending on R&D by a firm translated into more innovations; **b)** in the 1960s , the process of innovation started to give more importance to the needs of the market, this being seen as an important source of ideas and needs that should be addressed by R&D to generate innovations; **c)** from the 1970s onward there was growing realization of the need for a balanced approach between supply of technology and the needs of the market, givring rise to the so-called interactive model of innovation between market needs and R&D; and **d)** the currrent innovation process is seen as involving system integration and networking, by which innovation is a joint and cooperative action of various internal and external actors of the firm, such as suppliers, customers and other public and private institutions.

Chan et al. (1990, p. 274), through an empirical study, examined the effects on stock prices of announcements of increases in R&D spending for high- and low-technology firms from July 1979 to June 1985. In short, companies that announced planned increases in spending on R&D have seen immediate increases of more than 1.4% on average in their stock prices. Perhaps even more revealing, high-tech companies announcing increase of spending on R&D above average for their industries tended to get the biggest immediate rewards, while low-tech companies have experienced drop in their stock price. It seems that investors are impressed when their money is spent on research in technology-intensive areas, but wary when a low-technology company spends money in research in a field that has become mature

The authors found a positive relation for high-tech companies and a negative one for low-tech firms. A postive and statistically significant serial correlation can be seen as momentary price evidence and would suggest that the returns in one period will probably be positive if the returns from the previous period are positive.

If financial markets only take a short-term view as many critics allege, they should react negatively to announcements that firms plan to invest in research and development. But the evidence suggests the contrary. Table 1 shows the market reactions to various types of investment announcements of firms.

Table1: Market reactions to investment announcements

Type of Announcement	Abnormal returns	
	on the day of the announcement	in the month of the announcement
Formation of joint-ventures	0.399%	1.412%
R&D spending	**0.251%**	**1.456%**
Product strategies	0.440%	-0.35%
Capital expenditures	0.290%	1.499%
All types of announcements	0.355%	0.984%

Source: (Damodaran, 1997, p. 216)

According to Damodaran (1997), the market reacts to announcements by firms. In the specific case of R&D spending, the announcement has a reaction on the abnormal returns both on the day of the announcement in the the subsequent month. In the case of the reaction in the month, which is 1.456%, it is higher than the average of all the announcements together, of 0.984%.

The Annual Indsutrial Survey (PIA) and the Technology Innovation Survey (Pintec), carried out respectively by the Institute for Applied Economic Research (IPEA) and the Brazilian Institute of Geography and Statistics (IBGE) for 2000 and 2003, identified some basic characterisics of the profile of Brazlian industry regarding technological intensity. Only 1.72% of the 72 thousand Brazilian industrial firms "invest" in research and development of new technologies. However, the group of 1.2 thouasand companies that make such investments earn 30% more on average than the others and are 16 times more likely to export. These companies invest at least 3% of their annual gross revenue in research. Also, the IPEA study found that 15.3 thousand firms that rely less on technology managed

to reduce their costs by 0.99% a year, since they work with more standardized products with longer life cycles. To carry out the study, the IPEA relied on data from the IBGE, Foreign Commmerce Secretariat, Ministry of Labor and Brazilian Central Bank.

The studies carried out by Morbey (1989), Hasenclever (1997), Morbey and Reithner (1990), Dugal and Morbey (1995), Odagiri (1993), Matesco (1993), Chandler (1990) and Wolff (1995) all show a relationship between R&D spending and some results, such as earnings, revenue and number of patents. Among these relations are: a) percentage of net revenue spent on R&D of more than 2%; b) positive relationship for some specific economic sectors, such as chemicals, computers and machinery; c) indicators that oligopolistic market structures promote innovation and is still limited to a company's market share. There are various types of research and development, varying from basic research to studies aimed at the company's business setting. These last two are the focus of this study, because their results are preceived in the short term, continually and respectively.

2.1 Classification of Firms regarding R&D Intensity

According to Russel et al. (1992, p. 6), the characteristics of the economic sector and market should be the key determinants of firms' R&D efforts. These efforts are a function of the type and life cycle of the main products, position in the productive chain, competition, appropriability, etc. To standarize the classification of Latin American firms according to their characteristics and specificities, the Botoga Manual was developed by the Ibero-American Network of Science and Technology Indicators (RICYT) of the Organization of American States (OAS) and the CYTED Program.

For the specification of the necessary capacities, the Bogota Manual gives emphasis to know-how, which is the fruit of the accumulation of a firm's technological capacity. According to the Oslo Manual (OECD, 2005), it is possible to classify companies by measuring their activities in the field of science and technology. Various studies undertaken in the United States have shown that for high-technology companies, R&D spending has a positive effect on stock price, and that R&D has a direct relationship with the country's gross domestic product (GDP).

Alves (2007) studied the market structure and technological effort in Brazil and identified that R&D spending is higher in high-technology sectors. According to the IBGE (2005), average R&D spendingn in Brazil that year was 0.51% of GPD, a figure that was forecast to rise to 0.65% in 2010.

Panel A: High-technology sectors	• Pharmaceuticals • Electronics • Information processing • Instruments • Semiconductors • Telecommunications • Aircraft
Panel B: Low-technology sectors	• Automotive • Construction materials • Conglomerates • Electrical equipment • Food and beverages • Fuels • Leisure • Machinery • Various industries • Paper and forest products • Tires and rubber

Chart 1: Classification of economic sectors regarding technological intensity.
Source: Chan et al. (1990)

Chan et al. (1990) tested the relationship between research and development spending and stock price, dividing firms by low-technology and high-technology sectors according to Chart 1. Their results indicated that the announcement of increases in R&D spending increased the share prices of high-tech firms and reduced the price of low-tech firms.

Chart 2 presents the classification of the technological intensity of economic sectors in Brazil. According to this scheme, there are two additional levels, medium-high and medium-low.

Level of technological intensity	Product sectors
High	• Medical equipment and instruments, precision instruments, optical instruments, industrial automation equipment, chronometers and other meters. • Electrical machines, devices and materials. • Electronic material and devices and communications equipment. • Office machinery and computer equipment. • Machinery and equipment. • Vehicles. • Oil refining.
Medium-high	• Pharmaceutical products. • Basic electronic material. • Tobacco products. • Chemical products. • Auto parts and accessories. • Pulp and paper.
Medium-low	• Iron and steel products. • Rubber and plastic goods. • Metal products – other than machinery and equipment. • Nonferrous metallurgy and metal casting. • Paper, packaging and paper articles. • Non-metallic mineral products. • Leather, leather goods, luggage and footwear.
Low	• Textile products. • Food products. • Furniture. • Extractive industries. • Clothing and accessories. • Wood products. • Publishing, printing and reproduction of recordings. • Beverages. • Coke, alcohol and nuclear fuels.

Chart 2: Classification by technological intensity of brazilian economic sectors.
Source: IBGE, Annual Industrial Survey (2003).

According to the IBGE (2005), although Brazilian firms *"invest"* in R&D, the percentage is only 0.6% of revenue, versus 1.8% in developed countries that are members of the Organization for Economic Cooperation and Development (OECD). Nevertheless, in the Brazilian petroleum industry this figure is in the range of 3.6%. This can be explained by the extensive R&D required for offshore petroleum exploration and production activities in deep waters. The other sector in Brazil that stands out for R&D expenditures is the aircraft industry, where the figure is 8% of revenue.

2.2 The Ohlson Model and the Relevance of Accounting Information

The studies of Ohlson evolved from the publication in 1995 of the work containing the Residual Income Valuation (RIV) model to the Abnormal Earnings Growth (AEG) model. The concept of abnormal

earnings used in the model of Ohlson (1995) is that the abnormal earnings in a period is expressed by the difference between the earnings per share in this period and the product of the book value from the preceding period with the risk-free rate of return in the period (LOPES, 2001, p. 155). This concept is presented in Formula (1).

$$Ab_{ij} = EPS_{ij} - (BV_{ij-1} \bullet r_j)$$ (1)

Where:
Ab_{ij} = abnormal return per share of firm i in period j;
EPS_{ij} = earnings per share of firm i in period j;
BV_{ij-1} = book value per share of firm i in period $j-1$; and
r_j = risk-free rate of return in period j.

According to Lopes (2001), for abnormal earnings to be the focus of attention, instead of dividends, to predict the future value of companies, the premises of the Ohlson model that deserve emphasis are: (i) in principle, the a firm's value is equal to the present value of its expected future dividends and (ii) the book value in a period is equal to the book value in the immediately preceding period plus the earnings in that period less the dividends distributed in the period, so (iii) the dividends distributed affect the book value for the period but do not affect the earnings of the period (only the earnings for future periods), and so (iv) these can be "replaced" by the market value in a one-to-one relation, making (v) the dividend distribution strategy irrelevant to calculate the value (share price) of the firm, which (vi) becomes a function of the abnormal future earnings, according to the following formula:

$$P_{ij} = BV_{ij} + \sum_{t=1}^{\infty} \frac{E_j \left[Ab_{ij+t} \right]}{(1+r)^t}$$ (2)

Where:
P_{ij} = price per share of firm i at the end of period j;
BV_{ij} = book value per share of firm i at the end of period j;
Ab_{ij+t} = abnormal return (as expressed before) per share of firm i for periods $j+1, j+2, ... , j+t$;
$E_j [ ]$ = mathematical operator of the expected value conditional on the information possessed on date j; and
r = risk-free rate of return.

This model has been widely used for empirical research. Despite its widespread acceptance in the academic community, it was improved by Ohlson himself, becoming the abnormal earnings growth (AEG) model. Collins et al. (1997, p. 45) performed a study based on the model of Ohlson (1995), structuring the following formula to explain current market price:

$$\mathbf{P_{it}} = \alpha_0 + \alpha_1 E_{it} + \alpha_2 BV_{it} + \varepsilon_{it}$$ (3)

Where:
P_{it} = price per share of firm i three months before the end of fiscal year t;
E_{it} = earnings per share of firm i during fiscal year t;
BV_{it} = book value per share of firm i at the end of fiscal year t; and
ε_{it} = error term of the regression.

Collins et al. (1997, p. 45) performed their study to identify: (a) the incremental explanatory power of earnings; (b) the incremental explanatory power of book value; and (c) the common explanatory power of earnings and book value. Based on that study by Collins et al. (1997), Rezende (2005, p. 33) analyzed the effects of R&D investments (measured by deferred assets) on the value-relevance of earnings and book value for firms belonging to both the so-called new and old economies, with the sectors of the old economy serving for comparative purposes. More specificlly, the objectives of the article were to analyze: (i) the explanatory power of earnings and book value; and (ii) the incremental explanatory power of deferred assets, were the stock price is a function of earnings and book value less deferred assets.

Therefore, based on the formulation proposed by Collins et al. (1997), Rezende (2005, p. 40) presented the following model:

$$_{(i)} \mathbf{P_{iA96}} = {}_{95}\omega_0 + {}_{95}\omega_1 NP_{ij} + {}_{95}\omega_2 BV_{ij} + \varepsilon i_{95} \tag{4}$$

$$_{(ii)} \mathbf{P_{iA96}} = {}_{95}\omega_0 + {}_{95}\omega_1 E_{ij} + {}_{95}\omega_2 (BV_{ij} - DFA_{ij}) + {}_{95}\omega_3 DFA_{ij} + \varepsilon i_{95} \tag{5}$$

Where:
P_{iA96} = price per share of firm i 4 months after the end of fiscal year j (end of April in the Brazilian case);
BV_{ij} = book value per share of firm i at the end of fiscal year j;
DFA_{ij} = value of deferred assets per share of firm i at the end of fiscal year j;
E_{ij} = earnings per share of firm i at the end of fiscal year j; and
ε_{ij} = error term of the regression.

According to Rezende (2005, p. 41), the study sought to analyze Brazilian companies in the telecommunications sector, with high concentration of intangible assets, firms in the steel sector, with low concentration of intangibles, and companies in the banking and insturance sector, these last for compariative purposes.

For the telecommunications sector, Rezende (2005) found evidence corroborating the findings of Lopes (2001), in the sense that the study presented a proxy to explain stock prices, but the results ran counter to those found by Amir and Lev (1996).

2.3 Accounting for Spending on Research and Development

The basic corporate law in Brazil, Law 6,404/76, which contains the basic requirements for corporate accounting, was amended in important respects at the end of 2007 by Law 11,638/07. A key change was the possible treatent of spending on R&D, which can now be recorded in the deferred assets group in cases where the expenditures will benefit the company for various years, but can also be recorded as expenses. According to the old rules, deferred assets could consist of spending on construction and pre-operational expenses, spending to implement systems and methods, spending on reorganization and spending on research and development. Under the new rules, R&D spending may be recorded under earnings (expenses) or investments. When recorded as investments, R&D spending now composes the intangible assets (a new rubric of the "permanent assets" group). To be given this accounting treatment, the spending must meet the criteria and requirements set forth in Technical Pronouncement 4 from the Accounting Pronouncements Committee (CPC 04: Intantible Assets).

The purpose of the new rules on the accounting treatment of R&D spending in the Law of Corporations was to bring Brazilian practices in line with those of the International Accounting Standards Board, as contained in IAS 38 (IASB, 1999). According to this set of rules, research spending is recorded directly under earnings (expenses). In turn, spending on development can be capitalized if and only if the company can demonstrate its investment characteristics, according to paragraph 45 of IAS 38.

2.4 The Relevance of R&D Spending for Stock Price

Amir and Lev (1996) tested the relevance of the accounting and nonfinancial information of mobile telephone companies. The aim of the study was to investigate whether accounting information could be used to predict the value of high-technology firms. The authors concluded that the accounting practices in force (US-GAAP) were responsible for the weak performance of accounting numbers, by not permitting firms to record R&D spending as investments in intangible assets.

Following the research line of Amir and Lev (1996) and to continue and expand on the work of Lopes (2001), Rezende (2005) developed a study of firms separated between those in the new and old economy and found that accounting information for the sectors studied was relevant for the firms' stock prices. However, the results on the explanatory power of deferred assets ran oppositc to the expected results.

Rezende (2005, p. 48) examined three sectors of the economy: telecommunications, iron and steel and banking. He found that the amount of deferred assets recorded, according to the accounting rules then in force, had low explanatory power for the three sectors analyzed. He also found an inverse effect of deferred assets, that is, they reduced the model's explanatory power. Nevertheless, he did not reject the hypotheses posed, arguing there was a need for further and more detailed investigation of the subject.

Seeking to test the relevance of deferred assets, Rezende (2005, p. 34) estimated regressions between the years 1995 and 2003, employing R^2 as the metric to evaluate the explanatory power of earnings and book value. The author sought to exlain the incremental explanatory power of deferred assets in a model in which price is a function of earnings and book value minus deferred assets. In essense, he tested in isolation the impact of the "deferred assets" variable on stock price.

The results showed that in the telecommunications sector, intangible assets (deferred assets) had low explanatory power. Only in 1996 did this variable present a statistically significant coefficient, at the 95% confidence level. The author also tested the iron and steel sector and found that for the period analyzed (1995 to 2003), deferred assets presented statistically significant coefficients only in 1999, 2002 and 2003. Finally, he also tested, for comparative purposes, the banking sector, finding the following results:

> In the analysis of the banking sector, the findings indicated that the amount of deferred assets has low explanatory power in relation to net earnings and book value. More specifically, when deferred assets are dismembered (subtracted) from BV and included in the model, it has an inverse effect, i.e., it reduces the model's explanatory power. It should be stressed that, in the periods analyzed, both earnings and book value of the firms considered presented statistically significant coefficients (REZENDE, 2005, p.48).

3. METHODOLOGY

This study was based on the model of Collins et al., a proxy for the model of Ohlson (1995), as applied by Rezende (2005) to identify the relevance of intangible assets in the stock price of firms listed on the Bovespa. We extended on his model, with the following configurations.

We applied equation (4), employed by Rezende (2005), to identify the relevance of net earnings and book value on stock price, while we applied equation (5) to identify the relevance of deferred assets for stock price, as follows and as presented in the theoretical framework section of this work.

$$\mathbf{P_{A96}} = {}_{95}\omega_0 + {}_{95}\omega_1 E_{ij} + {}_{95}\omega_2 BV_{ij} + \varepsilon i_{95} \tag{4}$$

$$\mathbf{P_{iA96}} = {}_{95}\omega_0 + {}_{95}\omega_1 E_{ij} + {}_{95}\omega_2 (BV_{ij} - DFA_{ij}) + {}_{95}\omega_3 DFA_{ij} + \varepsilon i_{95} \tag{5}$$

Seeking to extend the study of Rezende (2005), we applied equation (6) below to identify the relevance of investments in R&D for stock price, following the orientations of Brown et al. (1999) with the objective of minimizing the scale effect, by dividing the variables by the stock price in the previous year, as follows:

$$\frac{P_{i,j}}{P_{t-1}} = \beta_0 + \beta_1 \frac{(LUC_j - PDd_j)}{P_{t-1}} + \beta_2 \frac{(P_j - PDa_j)}{P_{t-1}} + \beta_3 \frac{PDd_j}{P_{t-1}} + \beta_4 \frac{PDa_j}{P_{t-1}} + \beta_5 Dummy + \varepsilon_{i,j} \qquad (6)$$

Where:
$P_{i,j}$ = stock price of firm i 4 months after the end of fiscal year j (end of April in the Brazilian case);
P_{it-1} = stock price of firm i 4 months (end of April) after the end of fiscal year j;
E_{ij}- $RDexp_{ij}$ = earnings per share of firm i at the end of fiscal year j minus the R&D expense per share at the end of fiscal year j;
BV_{ij}-RDa_{ij} = difference between the book value per share and the R&D (intangible) assets per share of firm i at the end of fiscal year j;
RDa_{ij} = value of R&D assets per share of firm i at the end of fiscal year j;
$RDexp_{ij}$ = value of R&D expense per share of firm i at the end of fiscal year j;
Dummy = indicator variable to classify the technological intensity of the firms, as high (1) or low (0); and
ε_{ij} = error term of the regression.

In the present study, we applied the empirical analytic method, which is applicable to understand phenomena observed in practice and to relate them to the existing theories. Hence, this work has a combination of exploratory, descriptive and explanatory characteristics, based on theoretical references to test the research hypotheses, so it can be classified as empirical-analytic. We compared and tested the real data against the existing theories.

3.1 Classification of the Technological Intensity of the Economic Sectors
The Oslo Manual (2005) and Bogota Manual (2001), the latter adjusted for the characteristics of Latin American companies, define criteria for classification of the technological intenstity of economic sectors. Based on these parameters, we classified the technological intensity of the firms listed on the Bovespa in our sample, as presented in Chart 3.

Sectors	Classification
Vehicles and parts	High Technology
Transportation services	High Technology
Petrochemicals, plastics and rubber	High Technology
Pharmaceuticals	High Technology
Industrial machinery	High Technology
Chemicals	High Technology
Finance and insurance	High Technology
Telecommunications	High Technology
Electrical-electronics	High Technology
Pulp and paper	High Technology
Other industrial activities	Low Technology
Steel and metallurgy	Low Technology
Construction	Low Technology
Food and beverages	Low Technology
Commerce	Low Technology
Electricity	Low Technology
Mining	Low Technology
Textiles	Low Technology

Chart 3: Classification of the technological intensity of the economic sectors of the Bovespa
Source: Authors.

In analyzing Chart 3, it can be seen that "other industrial activities" was classified as a low-technology sector. This classification was based on the characteristics of the firms included in the sample.

The universe studied covers all the companies listed on the Bovespa in any year during the period from 1999 to 2006 (thus including companies whose listings were canceled for any reason). The sample was taken from the database of Economática, a firm specialized in information about the capital market. The information on R&D was obtained from the fiancial statements of the firms, divided into expenditures recorded as investments, taken from the balance sheet (deferred assets account), and expenditures recorded as expenses, taken from the notes to the financial statements in the annual reports.

3.2 Selection of the Sample

In addition to the information on R&D extracted from the financial statements and classified as investment or expense, we obtained the closing stock prices from the Economática and Bovespa databases. We considered the type of share and consolidation data pertinent to information on R&D and the Bovespa company code. The types of shares utilized to apply the tests varied in function of the classification of the companies in the Bovespa, observed at the time of obtaining the information on R&D spending.

The stock prices used were the closing trading price on April 30th of each year, with a 15-day tolerance, since in some cases there were no trades on that date for firms in the sample. The other information for the variables in the model was obtained from the financial statements for December 31st of the preceding year to the stock price quotation.

We obtained information on R&D spending for 81 firms, for a total of 345 observations. After consulting the stock prices and accounting data, we reduced the number of firms to 60 and observations to 244. Then we eliminated the observations where the BV variable was negative and made other adjustments for statistical treatment of the data, applying the interquartile range technique to exclude outliers. After this filtering, there were 21 firms and 104 observations remaining in the final sample.

According to the interquartile range criterion, all the observations that are greater than the 3rd quartile plus 2.5 times the interquartile range (difference between the 3rd and 1st quartile) or less than the 1st quartile minus 2.5 times the interquartile range are classified as outliers. The companies in the sample were then grouped by economic sector, according to the sector classification of the Bovespa, and were classified accroding to technological intensity as high or low technology.

Chart 4 identifies the firms and their classification as being in high- or low-technology sectors after the statistical treatment of the data.

Low Technology	High Technology
Bandeirantes	Copesul - Cia Petroquímica do Sul
Celpe	EMBRAER - Emp. Bras. Aeron. S/A
Cemig	Fertibras
Cia CST	Millenium
Cia Sid Nacional	Petrobras
Cia Siderúrgica Paulista – COSIPA	Polialden
Coelba	Politeno
Coelce	Sadia S/A
Copel	Vicunha NE S/A - Ind. Textil
Eluma S.A Ind. Comércio	WEG S/A
Forjas Tauros	

Chart 4: Classification of the technological intensity of the firms in the sample
Source: Authors.

All the companies classified in the high-technology category accounted for R&D as investments (deferred assets).

3.3 Statistical Treatment of the Data

To eliminate the scale effect, as suggested by Brown et al. (1999), we divided all the variables in the regression by the price in the previous year, to prevent the size of the firms and number of shares to influence the R^2 of the regressions. We formulated the regression model to relate spending on R&D to stock price. For this purpose we utilized techniques of descriptive statistics and graphical analysis of multiple linear regression in pooled data, considering the model presented in equation 6.

The study was structured according to viable methodological standards, with definition of the necessary criteria for classification and analysis of the data. Nevertheless, some limtations should be mentioned: a) the scanty infromation on R&D spending and the low amounts, since only 1.72% of the companies reported R&D spending in the study period; b) the difficulty of selecting a consistent and definitive model to classify firms' technological intensity — according to Lopes (2002), few Brazilian firms have shares listed for exchange trading; and c) the difficulty of obtaining information on the exact day of disclosure of R&D spending, and the fact that informal information can become available before the date of official announcement.

4. RESULTS

Table 2 shows the descriptive statistics of the variables applied in the model, all scaled by stock price in the previous year, which should be done for correct interpretation of the relative values. The data in Table 2 refer to the descriptive statistics of the sample, considering the years by means of pooled data. By this method, all the data are grouped linearly without considering the effect in time.

Table 2: Descriptive statistics of the study results

	Mean	Median	Standard deviation	Minimum	Maximum
Price per share	1.422	1.359	0.665	0.000	3.698
Earnings – R&D	0.289	0.225	0.451	-1.211	2.756
BV – R&D	2.441	1.865	2.036	0.114	10.246
R&D assets	2.91E-05	1.41E-07	8.32E-05	0.000	4.99E-04
R&D expenses	7.58E-06	0.000	2.84E-05	0.000	1.78E-04
HT/LT	0.442	0.000	0.499	0.000	1.000
BV	2.441	1.847	2.036	0.113	10.246
Earnings	0.289	0.225	0.451	-1.211	2.756

Table 2 presents the descriptive statistics of the variables contained in the descriptive model. The price per share variable corresponds to the stock price on April 30th with a 15-day window. The variability of this variable is low (standard deviation: 0.665). This occurs because of the small number of firms analyzed after eliminating the outliers (21 firms). Earnings – R&D (earnings minus R&D expense) corresponds to the earnings per share minus the amount spent on R&D per share when recorded as an expense at year-end. BV – R&D (book value minus R&D investment) corresponds to the BV per share minus the amount spent on R&D per share when recorded as investment at year-end. The variables R&D assets and R&D expenses correspond to the R&D amounts recorded as investments and expenses, respectively. Finally, HT/LT corresponds to the dummy variable for high- or low-technology company, with values of 1 and 0 respectively.

Table 3 presents the impact of R&D on the stock price of the firms in the sample (equation 6). The dependent variable (stock price) was taken from the database of Económatica on April 30, the deadline for listed companies to submit their financial statements to the Brazilian Securities Commission (CVM).

Table 3: Impact of R&D on the stock price

Variables	Expected Sign	Coefficient	p-value	VIF
BV - R&D	+	-0.05	0.15	1.21
Earnings - R&D	+	0.88	0.00	1.21
R&D assets	+	675.42	0.49	1.14
R&D expenses	+	1.074.35	0.45	1.10
HT/LT	+	-0.12	0.33	1.07
Sample size			104	
Adjusted R^2			32.47%	
SK test of normality			0.0584	
Durbin-Watson test			2.08	

Table 3 presents the results of the descriptive statistics. The variables BV-R&D, R&D assets, R&D expenses and HT/LT were not statistically significant in the model. Only the variable Earnings-R&D (earnings minus R&D expenses) was considered statistically significant, including at the 1% level (p-value < 0.001). All the tests of the prerequisites for multiple linear regression were satisfied: (i) normality, by means of testing for asymmetry and kurtosis (SK test), where the null hypothesis is that the data are normally distributed; (ii) independence of the residuals, by means of the Durbin-Watson test, demonstrating the absence of serial autocorrelation; (iii) inexistence of multicollinearity, confirmed by the variance inflation factor (VIF) test, in which all the values were below 5; and (iv) test of homoscedasticity, which was rejected, requiring the regression to be performed again with robust correction of the coefficients of the betas.

The use of dummy variables for the year aimed to capture the effect of the variables studied over time. However, as can be seen in Table 4, there are no indications of significant variations according to year.

Table 4 presents the results with the dummy for each year in the sample.

Table 4: Impact of R&D on stock price by year

Variables	Expected sign	Coefficient	p-value	VIF
BV - R&D	+	-0.01	0.70	1.57
Earnings - R&D	+	0.77	0.00	1.25
R&D assets	+	812.48	0.32	1.12
R&D expenses	+	1.804.20	0.26	1.10
HT/LT	+	-0.07	0.59	1.35
Dummy 2000		-0.20	0.37	4.60
Dummy 2001		-0.21	0.18	4.55
Dummy 2002		-0.21	0.20	4.31
Dummy 2003		-0.32	0.10	4.34
Dummy 2004		-0.30	0.87	4.24
Dummy 2005		-0.22	0.26	2.27

Dummy 2006	+	Dropped		
Sample size			104	
Adjusted R^2			41.24%	
SK test of normality			0.0307	
Durbin-Watson test			1.98	

Table 4 presents the results of the descriptive statistics in pooled form, utilizing dummy variables for each year. In the previous analyses, only the variable Earnings - R&D (earnings minus R&D expenses) was considered statistically significant (p-value < 0.001). The dummy for 2006, because there were only 5 observations, was dropped from the model due to the low variability. The data were generated using the robust resource for tests of coefficients. The Durbin-Watson test showed the absence of serial autocorrelation.

The results found here corroborate the findings of Lopes (2001), which run counter to those of Amir and Lev (1996), supporting the relevance of accounting information. The study complements the results found by Rezende (2005), who tested the value-relevance of deferred assets on stock prices. Specifically in relation to the study by Rezende, we went beyond his investigation (which only tested the value-relevance of R&D investments, represented by deferred assets), by separately examining R&D spending accounted for as expense and as investment.

The results in this respect were different for the two categories of R&D spending. Based on the division of the firms as relying on high or low technology, all the firms that recorded R&D investments were in the high-technology category and the large majority of the firms recording R&D expenses were classified as low-technology.

For the sample studied, there was no relationship between R&D spending, either classified as investment or expense, and the stock price (p-value < 0.05). These results were not signficant when classifying the firms into high- or low-technology sectors, which was one of the hypotheses of this study. Therefore, R&D spending (investments) does not have a positive statistical relationsip with the stock prices of the high-tech firms in the sample and R&D spending (expenses) does not have a negative statistical relationship with the stock prices of the low-tech firms.

When testing the impact of BV - R&D assets (book value less R&D assets), we did not find statistical significance for this variable. However, BV has been considered relevant in various other workds, such as those by Ohlson (1995) and Lopes (2001; 2002; 2005). Table 4 demonstrates that this variable is not significant. In other words, R&D spending recorded as investment is one of the factors that makes BV relevant for the market. The situation is different for earnings, because even after subtracting R&D expenses from earnings, this variable continued being statistically significant to determine stock prices.

5. FINAL CONSIDERATIONS

The results of analyzing the data provide some insights that can support decisions by business leaders and formulators of public policies in the area of technology. Among them are that spending on R&D does not appear to have a statisitically significant effect on stock prices. This finding does not corroborate the results found in the Unted States (CHAN et al., 1990; DAMODARAN, 1997), but this study complements other research that has tested the relevance of accounting information in Brazil. The analysis of the results of the statistical tests applied permitted reaching the following answers to the two hypotheses formlated: rejection of H0a, because R&D spending is not significant in the stock prices of the high-technology firms analyzed, and rejection of H0b, because R&D spending also was not significant for the stock prices of the low-technology firms analyzed.

Although the R&D spending cannot be considered statistically significant for the stock prices of the firms in the sample, when analyzing the variables BV - R&D assets (BV minus R&D assets) and Earnings - R&D expenses (earnings minus R&D expenses), the results confirm the strategic importance of R&D spending for the market. The reason is that such spending can be accounted for as expense or investment, considering the technological intensity of the firms. This technology aspect is relevant because all the firms accounting for R&D spending as investments were classified in high-technology sectors, while nearly all the firms recording R&D as expenses were in low-technology sectors.

R&D spending accounted for as investments integrates the deferred assets, with influence on the book value. Therefore, when R&D investments are subtracted from the BV, the result is a reduction in future returns, affecting the relevance of the BV for the stock price. Therefore, it can be said: (i) R&D spending recorded as expenses, in the case of the firms studied, did not affect the significance of earnings, because the R&D amounts expensed were considered low, especially because this is a practice of low-technology firms, as shown in Table 2 – Descriptice statistics of the study results; and (ii) in the case of R&D investments, the amounts are an element of deferred assets, which are part of the book value, so if they are eliminated, the BV will decline unfairly, because deferred assets are composed of elements that will still generate results for the company (expectation of future positive resturns). In previous studies, Morbey (1989), Hasenclever (1997), Morbey and Reithner (1990), Dugal and Morbey (1995), Odagiri (1993), Matesco (1993), Chandler (1990) and Wolff (1995) found a relationship between R&D and some accounting numbers, such as earnings, sales revenue and value patents.

The relatoins described in this paper have some restrictions, howver, such as: a) percentage of R&D spending on net revenue greater than 2%; b) positive relationship for some specific sectors of the economy, like chemicals, computers and machinery; c) market structure, such as indications that oligopolistic structures are proptitious for innovation and also limit firms with a considerable market share. These restrictions were also found by Alves (2007), who identified that the impact of R&D on business results is related to various characteristics of the market structures and the firms that compose them.

The present study generates contributions for new studies, among which we can suggest: a) analysis of the relationship between R&D spending and the process of liquidation of companies, since some of the low-technology companies that spent on R&D after some years ceased to be listed on the Bovespa; b) examination of the relationship between R&D spending and stock price and comparison with market value, aiming to propose adjustments in the valuation process regarding treatment of R&D spending, considering the market structures of firms, since high-technology companies' R&D spending can generate different results than such spending by low-technology firms; d) testing the relationship between R&D and the information involved in the decomposition of the book value; and e) formulation of a method for classifying the technological intensity of firms, considering the variables and characteristics of their economic sectors.

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