

Original Research Article Influence of Training Investment, Industry and Country of Origin on Performance of Firms across Time

ABSTRACT

The way firms, industries and countries influence organizational performance over time is not clear and the literature has not reached a consensus. Based on the initial hypotheses that significant alterations have occurred in the performance of companies that operate in Brazil in recent years, and that these variations occur in function of existing characteristics in each firm, each industry and each country of origin, this study proposes, through hierarchical modeling with repeated measures, an approach that permits analyzing the random effects as an alternative for the assessment of profitability evolution. Using a sample of 242 companies from 9 countries over 8 years (2007-2014), totaling 1,257 observations, it is verified that investments in internal training and the activity sector are representative to differentiate between companies' mean performance and growth rates in recent years. The results contribute to the understanding of the determining factors, at multiple levels, of companies' performance over time.

Key words: performance analysis; hierarchical models; repeated measures; firm effect; industry effect; country effect.

1. INTRODUCTION

Many studies on company profitability in Brazil and abroad address aspects related to the impacts produced by a certain group of variables on a specific behavior that provides information to decision makers. In this sense, multivariate quantitative data tools proliferate in important business strategy studies that aim to create models to explain reality and to empirically verify observed phenomena.

In this approach, many studies use quantitative data analysis techniques to solve problems and elaborate models that explain and forecast reality. According to Barth, Beaver and Landsman (2001, p. 77-104), econometric techniques are used in much relevant research. Without them, the validity of their inferences would be limited. However, it is fundamental for the appropriate choice of each statistical technique to be based on an underlying theory and in accordance with what the research intends to look at.

In this sense, this study adopts the multilevel approach, exploring the effects of companies' activity sector, their investments in internal training and their country of origin on the performance of companies listed in the ranking of the 500 best and biggest companies issued by Revista Exame, between 2007 and 2014. According to Goldszmidt, Brito and Vasconcelos (2007), the search for the origins of some companies' performance is a central

theme in business strategy research, and a research line about performance variance components has offered important empirical support in this search.

According to the same authors (2007), this line dates back to the studies by Schmalensee (1985, p. 341-351) and Rumelt (1991, p. 167-185), followed by a series of other studies that analyzed the firm, corporation, industry and year effects, like Roquebert, Phillips and Westfall (1996, p. 653-664), McGahan and Porter (1997, p. 15-30), Brush and Bromiley (1997, p. 825-835), Brush, Bromiley and Hendrickx (1999, p. 519-547) and Bowman and Helfat (2000, p. 1-23).

This article contributes to the study about the source of heterogeneity in company performance over time, specifically in terms of the firm, activity sector and country of origin effects, using multilevel techniques. First, it assesses existing performance variation among companies from the same country and different country over time. Next, it looks at the variables related to the firms (investment in internal training and activity sector) and to the countries of origin, which may explain profitability variations among firms over time. Thus, a three-level approach will be used. The first level is related to the time variation (repeated measure), the second to the firms' investment and activity sector characteristics and the third to the countries' variables.

Through hierarchical modeling with repeated measures, the authors explore the firm and activity sector effects, analyzing a sample of 242 firms working in 3 economic sectors (industry, wholesaling and retailing) and coming from 9 countries, over an 8-year period (2007-2014), totaling 1,257 observations.

In the next two sections, a review of hierarchical models is presented and the main concepts are discussed with respect to three-level hierarchical modeling with repeated measures, emphasizing studies that used the firm and country of origin effects on performance. Section 4 addresses the method and the model proposed in this research. Section 5 presents the results and respective discussions. The main conclusions are discussed in the final section.

2. MULTILEVEL MODELS AND THE EFFECTS OF FIRM AND ACTIVITY SECTOR ON PERFORMANCE

Most data studied in social sciences come from phenomena in which the subjects naturally present themselves hierarchically (SOTO and MORERA, 2005). According to Raudenbush, Bryk, Cheong, Congdon and du Toit (2004), behavioral, social data or data related to performance variables commonly present nested structures and each sub-model represents the structural relations and residual variability that occur at that level.

Many situations with a hierarchical structure exist, such as students belonging to schools that belong to secretaries of education, patients in clinics, voters in election zones, homes in cities and cities in states, individuals in economic sectors, and companies in sectors or countries of origin. Hierarchies correspond to the idea according to which the subjects that belong to the same group share a set of stimuli that favors homogeneity.

According to Gelman (2006, p. 432-435), multilevel models are a generalization of regression methods and, therefore, can be used for a range of purposes, including prediction, data reduction and causal inference based on experiments and observational studies. Recent and significant contributions about the subjects are found in Hofmann (1997, p. 723-744), Kreft and de Leeuw (1998), Snijders and Bosker (1999), Raudenbush and Bryk (2002), Hox (2002) and Goldstein (2003).

In comparison with classical linear regression and covariance analysis models, the advantage of multilevel models is that they take into account the analysis of hierarchically structured data. These models propose an analytic structure in which the distinct levels at which data articulate can be acknowledged, with each sub-level being represented by its own model (DRAPER, 1995, p. 115-147). According to Soto and Morera (2005), each of

these sub-models expresses the relation among the variables inside a certain level and specifies how the variables at this level influence the relations established at other levels.

A classical regression model, applied, for example, to a context of performance analysis of firms in a certain country, can be:

$$y_i = \beta_0 + \beta_1 \cdot X_{1i} + r_i \quad (1)$$

Equation (1) represents the relation between the performance variables (e.g. firm profitability) and the predicting variable (e.g. whether the firm works in the retailing or industrial sector). The constant β_0 represents the mean profitability of firms from that country active in retailing. In this example, the β_1 coefficient is the inclination of the regression and represents the mean profitability increase when the industrial sector is analyzed in comparison with the retailing sector. The r_i term refers to the extent to which firm i 's profitability is distanced from the expected profitability of firms with the same characteristic.

A generic graph can be elaborated to illustrate the case:

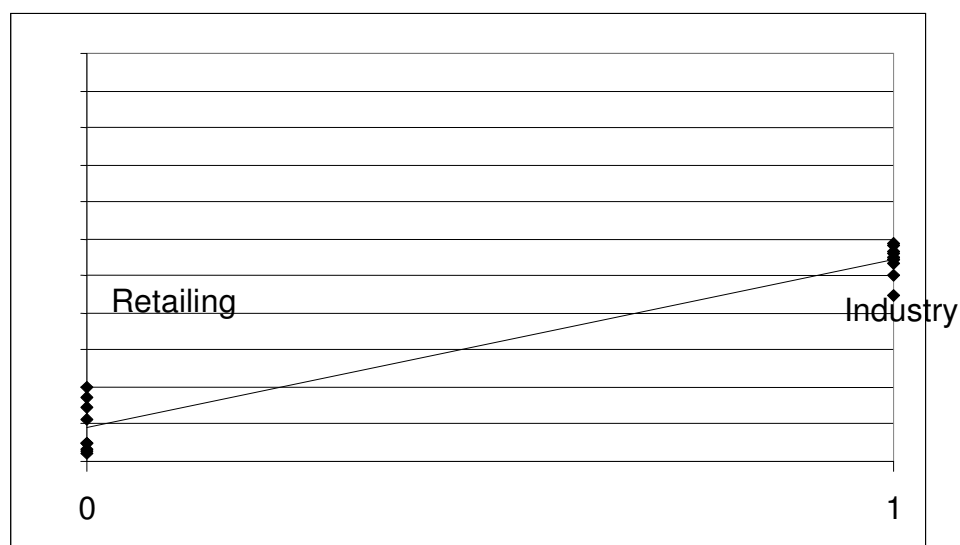


Fig. 1. Classical regression model for companies from one sector

Source: Adapted from Soto and Morera, 2005.

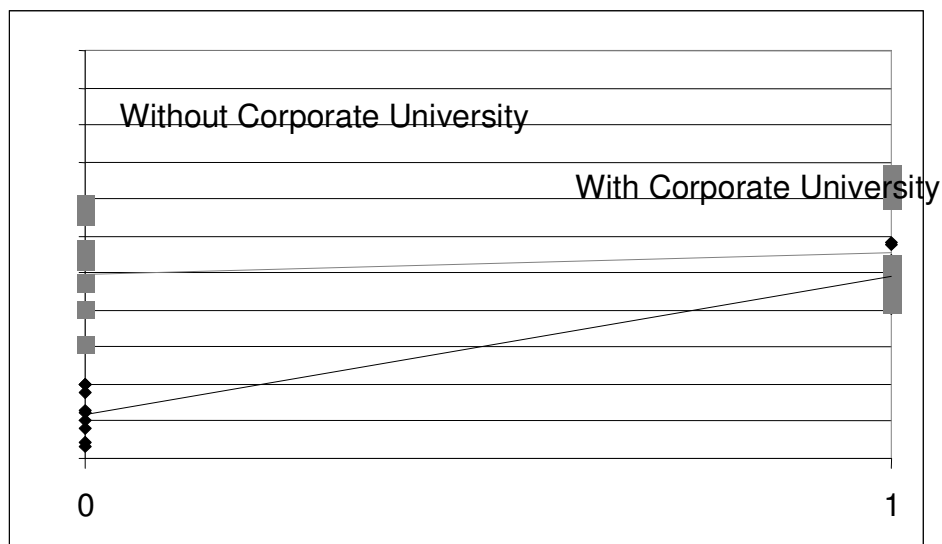
On the other hand, if the analysis is elaborated for firms from two different countries, two distinct equations need to be defined:

$$y_{i1} = \beta_{01} + \beta_{11} \cdot X_{11i} + r_{i1} \quad (2)$$

$$y_{i2} = \beta_{02} + \beta_{12} \cdot X_{12i} + r_{i2} \quad (3)$$

where the β_{01} and β_{02} coefficients represent the mean profitability expected from companies in each of these countries. The β_{11} and β_{12} coefficients are the inclinations and represent, likewise, the increase in mean profitability when the firms' activity sector changes. In the same way, a new generic graph can be elaborated:

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Fig. 2. Classical regression model for companies from two countries

Source: Adapted from Soto and Morera, 2005.

In fact, there are many countries of origin that can present mutual variations, in terms of cut-off points as well as inclinations, so that it is not very practical to estimate a regression equation for each of them.

Thus, estimating the firm and country effects demands a two-level model, with j countries at level 2 and i firms at level 1. Formally, there are $i = 1, \dots, n_j$ level 1 units (firms in this case), which are nested with each $j = 1, \dots, J$ level 2 units (countries in this case). Hence, the level 1 model can be written as:

$$y_{ij} = \beta_{0j} + \beta_{1j} \cdot X_{1ij} + \beta_{2j} \cdot X_{2ij} + \dots + \beta_{Qj} \cdot X_{Qij} + r_{ij} \quad (4)$$

$$y_{ij} = \beta_{0j} + \sum_{q=1}^Q \beta_{qj} \cdot X_{qij} + r_{ij}$$

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Where:

- β_{qj} ($q = 0, 1, \dots, Q$) are the level 1 coefficients;
- X_{qij} is the vector of q predictive variables at level 1 (firm variables) for case i (firm) from unit j (country);
- r_{ij} is the random effect of level 1; and
- σ^2 is the variance of r_{ij} (variance of level 1). It is assumed that the random term $r_{ij} \sim N(0, \sigma^2)$.

Likewise, the level 2 model can be written as:

$$\beta_{qj} = \gamma_{q0} + \gamma_{q1} \cdot W_{1j} + \gamma_{q2} \cdot W_{2j} + \dots + \gamma_{qS_q} \cdot W_{S_qj} + u_{qj} \quad (5)$$

$$\beta_{qj} = \gamma_{q0} + \sum_{s=1}^{S_q} \gamma_{qs} \cdot W_{sj} + u_{qj}$$

Where:

- γ_{qs} ($q = 0, 1, \dots, S_q$) are the level 2 coefficients;
- W_{sj} is the vector of predictive variables at level 2 (country variables); and
- u_{qj} is the random effect of level 2. It is assumed that, for each j unit, the vector $(u_{0j}, u_{1j}, \dots, u_{Qj})'$ presents a normal multivariate distribution, with each u_{qj} element having a zero mean and $\text{Var}(u_{qj}) = \tau_{qq}$ variance.

For each pair of random effects q and q' , it is given that:

$$\text{Cov}(u_{qj}, u_{q'j}) = \tau_{qq'} \quad (6)$$

Similar models have been widely used in business strategy literature to compare variance in variables present at the firm and sector levels to compose company performance. In this line, special attention should be given to the research by Mauri and Michaels (1998, p. 211-219), Chang and Singh (2000, p. 739-752), Ruefli and Wiggins (2003, p. 861-879) and Short, Ketchen Jr., Palmer and Hult (2007, p. 147-167).

Other authors have analyzed country of origin effects on company performance, particularly Collins (1990, p. 271, 288), Christmann, Day and Yip (1999, p. 241-265), Hawawini, Subramanian and Verdin (2004, p. 121-135), Makino, Isobe and Chan (2004, p. 1027-1043), Makino, Beamish and Zhao (2004, p. 377-392) and Goldszmidt, Brito and Vasconcelos (2007). Others have studied the city or micro-location effect to assess certain phenomena in people or companies, such as Price, Nero and Gelman (1996, p. 922-936) and Gelman (2006, p. 432-435).

This research intends to study whether companies' investments in internal training and activity sectors (firm effect) affect their performance and whether significant differences exist in these investments among companies from different countries over time, that is, using hierarchical models with repeated measures.

3. THREE-LEVEL HIERARCHICAL MODELS WITH REPEATED MEASURES

The use of models that consider the time variation in performance assessment has been increasingly frequent and represents new challenges when elaborating research projects and creating unbiased indicators (RAUDENBUSK and BRYK, 2002). Bliese and Ployhart (2002, p. 362-387) present how the modeling of random coefficients can be used to develop and test growth models when analyzing longitudinal data. According to Short,

Ketchen Jr., Bennett and du Toit (2006, 259-284), hierarchical models with repeated measures offer additional advantages because they allow researchers to model specific predicting variables at each analysis level, offering answers on how exact the influence of the firm, sector or location levels are over time.

Three-level models consist of 3 sub-models, in which there are $t = 1, \dots, T_{ij}$ years at level 1, which are nested in each $i = 1, \dots, n_j$ firms that, in turn, are nested in $j = 1, \dots, J$ countries. Hence, it is given for level 1 that:

$$y_{tij} = \pi_{0ij} + \pi_{1ij} \cdot \text{ANO}_{tij} + e_{tij} \quad (7)$$

Where:

- $t: 1, 2, \dots, T_{ij}$ (years), $j=1, 2, \dots, J$ (countries) and $i=1, 2, \dots, n_j$ (firms);
- ANO : Year;
- π_{0ij} : expected value of performance variable (mean) of company ij in year 1;
- π_{1ij} is the growth rate of company ij 's performance variable; and
- σ^2 is the variance of ε_{ij} (variance of a specific firm over time). It is assumed that the random term $\varepsilon_{tij} \sim N(0, \sigma^2)$.

Each level 1 coefficient becomes a dependent variable in the level 2 model. Hence, this can be written as:

$$\pi_{pij} = \beta_{p0j} + \beta_{p1j} \cdot X_{1ij} + \beta_{p2j} \cdot X_{2ij} + \dots + \beta_{pQpj} \cdot X_{Qpj} + r_{pij} \quad (8)$$

$$\pi_{pij} = \beta_{p0j} + \sum_{q=1}^{Q_p} \beta_{pqj} \cdot X_{qij} + r_{pij}$$

Where:

- β_{pqj} ($q = 0, 1, \dots, Q_p$) are the level 2 coefficients;
- X_{qij} is the vector of level 2 predictive variables; and
- r_{pij} is the random effect at level 2. It is assumed that, for each i unit, the vector $(r_{0ij}, r_{1ij}, \dots, r_{pij})'$ presents a normal multivariate distribution, with each r_{pij} element having a zero mean and $\text{Var}(r_{pij}) = \tau_{pp}$ variance.

For each pair of random effects p and p' , it is given that:

$$\text{Cov}(r_{pij}, r_{p'ij}) = \tau_{pp'} \quad (9)$$

Likewise, the level 3 model can be written as:

$$\beta_{pqj} = \gamma_{pq0} + \gamma_{pq1} \cdot W_{1j} + \gamma_{pq2} \cdot W_{2j} + \dots + \gamma_{pqS_{pq}} \cdot W_{S_{pq}j} + u_{pqj} \quad (10)$$

$$\beta_{pqj} = \gamma_{pq0} + \sum_{s=1}^{S_{pq}} \gamma_{pqsj} \cdot W_{sj} + u_{pqj}$$

Where:

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- γ_{pqj} ($s = 0, 1, \dots, S_{pq}$) are the level 3 coefficients;
- W_{sj} is the vector of predictive variables at level 3; and
- u_{pqj} is the random effect of level 3. It is assumed that, for each level 3 unit, the random effects vector (u_{pqj} terms) presents a normal multivariate distribution, having a zero mean and T_β covariance matrix.

Even 20 years after the pioneer study by Schmalensee, the theme still arouses interests. Many recent studies apply hierarchical models with repeated measures for company performance assessment, particularly Bergh (1993, p. 683-705), Bergh (1995, p. 1692-1708), Deadrick, Bennett and Russell (1997, p. 745-757), Adner and Helfat (2003, p. 1011-1025), Hough (2006, p. 45-61), Misangyi, Lepine, Algina and Goeddeke (2006, p. 5-28), Short, Ketchen Jr. Bennett and du Toit (2006, p. 256-284) and Goldszmidt, Brito and Vasconcelos (2007).

4. METHOD

The use of models that consider the time variation in performance assessment has been increasingly frequent and represents new challenges when formulating new problems aimed at measuring company performance (RAUDENBUSK and BRYK, 2002). And, according to Short, Ketchen Jr., Bennett and du Toit (2006, p. 259-284), the application of hierarchical models permits testing the relation between company performance and different environmental variables at the same time. Next, the sampling, variable selection, research hypotheses and the method itself are presented.

4.1. Sampling and Variable Selection

The database of the 500 Best and Biggest Companies issued by Revista Exame was the source for this research. Initially, data were extracted for all sets of companies available in the database for the period from 2007 to 2014.

The original database contained almost 1000 companies from 22 countries over 8 years, totaling 7,384 observations.

Following the same logic proposed by Goldszmidt, Brito and Vasconcelos (2007) for the exclusion criteria of observations, firms that presented some missing data related to the explanatory variables or performance variable were eliminated. Moreover, the criteria aimed to avoid indetermination in the allocation of the different effects due to the presence of less than two cases in each factor. Thus, firms were only maintained if they presented two or more periods of the dependent variable related in the database, and if there were two or more firms from a certain country in a specific year. Moreover, only firms that informed what percentage of their gross annual revenue they invested in internal training during each period were maintained.

In the end, 1,257 observations were included in the final sample, with 242 firms from 9 countries. This treatment offers an advantage when using multilevel models, which permit verifying what firm or country effects better explain performance variation over time.

The adopted performance variable is the adjusted profitability disseminated in the above mentioned ranking. The level 2 variable related to the activity sector was obtained from the same database. These and other variables (levels 2 and 3) are displayed in the chart below:

Chart 1. Definition of level 2 and 3 variables

Level 2 Variables (Firm)			
Activity	Sector	(Services, Industry,	Dummy Variables:
Warehousing / Retailing)			Services: IND = 0 and ATVAR = 0
			Industry: IND = 1 and ATVAR = 0

	Warehousing / Retailing: IND = 0 and ATVAR = 1
Percentage of Investment in Internal Training	TREIN
Level 3 Variables (Country)	
Competitiveness of Nations Index	ICN
per capita GDP	PPC
Participation in G8	Dummy: Non Participation in G8: G8 = 0 Participates in G8: G8 = 1

4.2. Hypotheses for Testing

This research assesses whether there are significant differences in company performance over time; if these differences are due to existing variations among firms in terms of internal training investments, activity sectors and countries of origin and, if yes, the reasons why these differences occur.

Thus, the hypotheses for testing are in line with the logic proposed by Short, Ketchen Jr., Bennett and du Toit (2006, p. 259-284) and can be described as follows:

Hypothesis 1: There exists significant variability in company performance over time.

Hypothesis 2: There exists significant variability in performance, over time, among firms from the same country.

Hypothesis 3: There exists significant variability in performance, over time, between firms from different countries.

Hypothesis 4: Companies' performance follows a linear trend over time and there is significant variance among them.

Hypothesis 5: The firms' characteristics, such as their investment percentage in internal training in relation to their gross annual revenue and their activity segment explain the performance variation over time.

Hypothesis 6: The countries' characteristics, such as the competitiveness ratio, per capita GDP or insertion in the G8 explain performance differences among the companies over time.

To verify each of these hypotheses, the method needs to be presented, as well as the proposed models.

4.3. Modeling

The method for hierarchical models with repeated measures involves a series of nested regressions that are interactively estimated through maximum likelihood estimation in the full concept (RAUDENBUSH and BRYK, 2002). According to Hofmann, Jacobs and Baratta (1993, p. 194-204) and Short, Ketchen Jr., Bennett and du Toit (2006, p. 259-284), the hierarchical models are most adequate than any other technique for the analysis of repeated measures, as they are capable of investigating and identifying patterns of systematic change individually over time. Thus, this analysis method considers one single performance trajectory for each firm, that is, it takes into account random effects to explain performance over time.

The models use 3 levels of analysis that represent, respectively, individual changes in companies' performance over time (level 1), performance variation among companies from the same country (level 2) and the variation among countries (level 3).

To verify the first 3 hypotheses presented, a model is proposed without predicting variables (null model), which offers estimations of the variance components in each firm (over time), among firms and among countries. The modeling provides χ^2 tests for the components among firms and among countries (RAUDENBUSH, BRYK, CHEONG, CONGDON and du TOIT, 2004). Hence, the null model can be written as:

Null Model

Level 1 (Repeated Measure):

$$RENT_{tij} = \pi_{0ij} + e_{tij}, \quad e_{tij} \sim NID(0, \sigma^2) \quad (11)$$

RENT: performance variable represented by adjusted profitability;

$t=1,2, \dots, T_{ij}$ (years), $j=1,2, \dots, J$ (countries) and $i=1,2, \dots, n_j$ (firms);

π_{0ij} : expected (mean) RENT of firm ij in year 1 (2007); and

σ^2 : variance "inside" the firm.

Level 2 (Firm):

$$\pi_{0ij} = \beta_{00j} + r_{0ij}, \quad r_{0ij} \sim NID(0, \tau_{\pi_0}) \quad (12)$$

β_{00j} : mean of expected RENT's in 2007 for country j ; and

τ_{π_0} : variance of expected RENT's in 2007 for country j .

Level 3 (Country):

$$\beta_{00j} = \gamma_{000} + u_{00j}, \quad u_{00j} \sim NID(0, \tau_{\beta_0}) \quad (13)$$

γ_{000} : general mean of expected RENT's in 2007; and

τ_{β_0} : variance among expected RENT's in 2007.

To verify the fourth hypothesis, two models are proposed which include a trend component (variation over time) in level 1. The first model does not include random effects and only tests if the companies' performance follows a linear trend over time. The second model, on the other hand, presents the inclusion of random effects and tests if significant variance among companies occurs in terms of the performance trend over time.

Linear Trend Model without Random Effects

Level 1 (Repeated Measure):

$$RENT_{tij} = \pi_{0ij} + \pi_{1ij}.ANO_{tij} + e_{tij}, \quad e_{tij} \sim NID(0, \sigma^2) \quad (14)$$

RENT: performance variable represented by adjusted profitability;

$t=1,2, \dots, T_{ij}$ (years), $j=1,2, \dots, J$ (countries) and $i=1,2, \dots, n_j$ (firms);

π_{0ij} : expected (mean) RENT of firm ij in year 1 (2007);

π_{1ij} : growth rate of firm ij 's RENT; and

σ^2 : variance "inside" the firm.

Level 2 (Firm):

$$\pi_{0ij} = \beta_{00j} + r_{0ij}, \quad r_{0ij} \sim NID(0, \tau_{\pi_0}) \quad (15)$$

$\pi_{1ij} = \beta_{10j}$

β_{00j} : mean of expected RENT's in 2007 for country j ; and

β_{10j} : mean of expected growth rates in country j ; and

τ_{π_0} : variance of expected RENT's in 2007 for country j .

Level 3 (Country):

$$\beta_{00j} = \gamma_{000} + u_{00j}, \quad u_{00j} \sim NID(0, \tau_{\beta_0}) \quad (16)$$

$\beta_{10j} = \gamma_{100}$

389 γ_{000} : general mean of expected RENT's in 2007; and
 390 γ_{100} : mean of growth rates of expected RENT's; and
 391 τ_{β_0} : variance among expected RENT's in 2007.

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393 **Linear Trend Model with Random Effects**

394 *Level 1 (Repeated Measure):*

$$395 \text{RENT}_{tij} = \pi_{0ij} + \pi_{1ij} \cdot \text{ANO}_{tij} + e_{tij}, \quad e_{tij} \sim \text{NID}(0, \sigma^2) \quad (17)$$

396 RENT: performance variable represented by adjusted profitability;

397 $t=1,2, \dots, T_{ij}$ (years), $j=1,2, \dots, J$ (countries) and $i=1,2, \dots, n_j$ (firms);

398 π_{0ij} : expected (mean) RENT of firm ij in year 1 (2007);

399 π_{1ij} : growth rate of firm ij 's RENT; and

400 σ^2 : variance "inside" the firm.

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402 *Level 2 (Firm):*

$$403 \pi_{0ij} = \beta_{00j} + r_{0ij}, \quad r_{0ij} \sim \text{NID}(0, \tau_{\pi_0}) \quad (18)$$

$$404 \pi_{1ij} = \beta_{10j} + r_{1ij}, \quad r_{1ij} \sim \text{NID}(0, \tau_{\pi_1})$$

405 β_{00j} : mean of expected RENT's in 2007 for country j ; and

406 β_{10j} : mean of expected growth rates in country j ; and

407 τ_{π_0} : variance of expected RENT's in 2007 for country j ; and

408 τ_{π_1} : variance of expected growth rates in country j .

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410 *Level 3 (Country):*

$$411 \beta_{00j} = \gamma_{000} + u_{00j}, \quad u_{00j} \sim \text{NID}(0, \tau_{\beta_0}) \quad (19)$$

$$412 \beta_{10j} = \gamma_{100} + u_{10j}, \quad u_{10j} \sim \text{NID}(0, \tau_{\beta_1})$$

413 β_{00j} : general mean of expected RENT's in 2007 for country j ; and

414 β_{10j} : mean of expected growth rates in country j ; and

415 τ_{β_0} : variance of expected RENT's in 2007 for country j ; and

416 τ_{β_1} : variance among expected growth rates.

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418 According to Short, Ketchen Jr., Bennett and du Toit (2006, p. 259-284), the
 419 significance of individual performance changes is tested in two ways. The first is a χ^2 test
 420 that compares the statistics of deviations between the model with the year effect (linear
 421 trend model) and the null model. The second offers a t test for the fixed effects and χ^2 for the
 422 variance components. The significance of the fixed effect for the periods suggests that the
 423 time effect is constant for all firms. However, the inclusion of random effects helps when
 424 verifying the existence of significant performance variability over time among firms from the
 425 same country (level 2) and among firms from different countries (level 3).

426 In case the hypotheses above are verified, predictive variables will be included at
 427 levels 2 and 3 to verify hypotheses 5 and 6, and the model becomes:

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429 **Full Model**

430 *Level 1:*

$$431 \text{RENT}_{tij} = \pi_{0ij} + \pi_{1ij} \cdot \text{ANO}_{tij} + e_{tij} \quad (20)$$

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433 *Level 2:*

$$434 \pi_{0ij} = \beta_{00j} + \beta_{01j} \cdot (\text{IND}) + \beta_{02j} \cdot (\text{ATVAR}) + \beta_{03j} \cdot (\text{TREIN}) + r_{0ij} \quad (21)$$

$$435 \pi_{1ij} = \beta_{10j} + \beta_{11j} \cdot (\text{IND}) + \beta_{12j} \cdot (\text{ATVAR}) + \beta_{13j} \cdot (\text{TREIN}) + r_{1ij}$$

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437 *Level 3:*

$$438 \beta_{00j} = \gamma_{000} + \gamma_{001} \cdot (\text{ICN}) + \gamma_{002} \cdot (\text{PPC}) + \gamma_{003} \cdot (\text{G8}) + u_{00j}$$

$$439 \beta_{01j} = \gamma_{010} + \gamma_{011} \cdot (\text{ICN}) + \gamma_{012} \cdot (\text{PPC}) + \gamma_{013} \cdot (\text{G8})$$

$$440 \beta_{02j} = \gamma_{020} + \gamma_{021} \cdot (\text{ICN}) + \gamma_{022} \cdot (\text{PPC}) + \gamma_{023} \cdot (\text{G8})$$

$$\begin{aligned}
 \beta_{03j} &= \gamma_{030} + \gamma_{031} \cdot (\text{ICN}) + \gamma_{032} \cdot (\text{PPC}) + \gamma_{033} \cdot (\text{G8}) \\
 \beta_{10j} &= \gamma_{100} + \gamma_{101} \cdot (\text{ICN}) + \gamma_{102} \cdot (\text{PPC}) + \gamma_{103} \cdot (\text{G8}) + u_{10j} \\
 \beta_{11j} &= \gamma_{110} + \gamma_{111} \cdot (\text{ICN}) + \gamma_{112} \cdot (\text{PPC}) + \gamma_{113} \cdot (\text{G8}) \\
 \beta_{12j} &= \gamma_{120} + \gamma_{121} \cdot (\text{ICN}) + \gamma_{122} \cdot (\text{PPC}) + \gamma_{123} \cdot (\text{G8}) \\
 \beta_{13j} &= \gamma_{130} + \gamma_{131} \cdot (\text{ICN}) + \gamma_{132} \cdot (\text{PPC}) + \gamma_{133} \cdot (\text{G8})
 \end{aligned}
 \tag{22}$$

The interpretation of the coefficients is the same as exposed above.

5. RESULTS

Using HLM 6.04 software, first, the null model was applied, in accordance with Snijders and Bosker (1999), Raudenbush and Bryk (2002) and Short, Ketchen Jr., Bennett and du Toit (2006, p. 259-284).

Table 1 presents the decomposition of variance among the levels. Thus, 8.834% of the performance variability occurred among firms ($\chi^2 = 877.242$, $p < 0.01$) and a relevant percentage of performance variation (91.165%) was due to the time evolution in each firm. On the other hand, it is verified that a small part of variance (0.001%) is due to differences among countries ($\chi^2 = 10.778$, $p > 0.05$).

Table 1. Decomposition of Variance: Null Model

Fixed Effect	Coefficient	Standard error	t
General mean RENT (γ_{000})	1.169	1.507	0.776
Random Effect	Variance Component	df	χ^2
Time variation (e_{tij})	8102.459		
Variation among firms (r_{0ij})	785.145**	233	877.242
Variation among countries (u_{00j})	0.098	8	10.778
Decomposition of Variance	% per Level		
Level 1 (time)	91.165		
Level 2 (firm)	8.834		
Level 3 (country)	0.001		

** $p < 0.01$.

Tables 2 and 3 display the results of the models, including the trend at level 1, without and with the random effects, respectively. The model without random effects (table 2) shows that the variable corresponding to the year (linear trend) with a fixed effect is significant ($t = 6.476$, $p < 0.01$). The analysis of table 3, which presents the results of the linear trend model with random effects, shows that the variance component for the linear trend is significant as well ($\chi^2 = 712.448$, $p < 0.01$).

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Table 2. Decomposition of Variance: Linear Trend Model without Random Effects

Fixed Effect	Coefficient	Standard error	t
General mean RENT (γ_{000})	-8.103**	1.392	-5.821
General mean of RENT growth rates (γ_{100})	2.053**	0.317	6.476
Random Effect	Variance Component	df	χ^2
Level 1			
Time variation (e_{tij})	8003.127		
Level 2			
Initial RENT of firms (r_{0ij})	737.594**	233	874.213
Level 3			
Mean RENT of countries (u_{00j})	0.037	8	10.513

491 ** p<0.01.

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Table 3. Decomposition of Variance: Linear Trend Model with Random Effects

Fixed Effect	Coefficient	Standard error	t
General mean RENT (γ_{000})	-7.964**	1.396	-5.705
General mean of RENT growth rates (γ_{100})	2.012**	0.348	5.782
Random Effect	Variance Component	df	χ^2
Level 1			
Time variation (e_{tij})	7996.120		
Level 2			
Initial RENT of firms (r_{0ij})	642.743**	233	733.667

Change rate of firms' trends (r_{1ij})	1.247**	233	712.448
Level 3			
Mean RENT of countries (u_{00j})	0.174	8	3,259
Change rate of countries' trend (u_{10j})	0.007	8	2.196

** p<0.01.

The analysis of tables 1, 2 and 3 shows support for hypotheses 1, 2 and 4. However, there is no support for hypothesis, as there is no significant performance variability among companies from different countries across the study period.

Thus, hypothesis 6 is automatically discarded, leaving only hypothesis 5 for analysis. Therefore, the full model will be tested, however, without level 3, as follows:

Level 1:

$$RENT_{ti} = \pi_{0i} + \pi_{1i} \cdot ANO_{ti} + e_{ti} \quad (23)$$

Level 2:

$$\pi_{0i} = \beta_{00} + \beta_{01} \cdot (IND) + \beta_{02} \cdot (ATVAR) + \beta_{03} \cdot (TREIN) + r_{0i} \quad (24)$$

$$\pi_{1i} = \beta_{10} + \beta_{11} \cdot (IND) + \beta_{12} \cdot (ATVAR) + \beta_{13} \cdot (TREIN) + r_{1i}$$

Table 4 presents the results of this model.

Table 4. Variance Decomposition: Full Two-Level Model

Fixed Effect	Coefficient	Std. Error	t
General mean RENT (β_{00})	-10.027**	1.717	-5.839
Influence of industrial sector on general mean RENT (β_{01})	4.127**	0.117	35.273
Influence of retailing sector on general mean RENT (β_{02})	5.478*	2.698	2.030
Influence of internal training on general mean RENT (β_{03})	7.787**	0.897	8.681

General mean of RENT growth rates over time (β_{10})	3.007**	0.412	7.298
Influence of industrial sector on general mean of RENT growth rates over time (β_{11})	-1.927**	0.478	-4.031
Influence of retailing sector on general mean of RENT growth rates over time (β_{12})	-1.343*	0.696	-1.929
Influence of internal training on general mean of RENT growth rates over time (β_{13})	0.979**	0.112	8.741

Random Effect	Variance Component	df	χ^2
Level 1			
Time variation (e_{ti})	8002.587		
Level 2			
Initial RENT of firms (r_{0i})	667.101**	238	738.558
Change rate of firms' RENT trend (r_{1i})	1.398**	238	717.895

517 * p<0.05.

518 ** p<0.01.

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520 The analysis of table 4 shows that the variables related to the activity sector
521 (Industry or Wholesaling / Retailing) are representative to differentiate the mean
522 performance and performance growth rates among companies over time. While companies
523 from the industrial sector present higher mean profitability than in the wholesaling and
524 retailing sector, on the other hand, there are greater drops in the former's profitability rates
525 year by year than in the latter. On the other side, it is highlighted that the variable related to
526 investments in internal training for the development of professionals and collaborators is
527 representative, and with a positive signal, to differentiate both mean performance and
528 performance growth rate among firms over time, which demonstrates the importance of this
529 variable. Thus, firms that offered an investment program in internal training across the study
530 period present higher mean profitability and higher profitability growth rates.

531 In general, 4 of the 6 hypotheses initially presented were supported by the results of
532 the hierarchical models. The results obtained through these variance component analysis
533 models are not restricted, as presented, to the specification of the performance variance
534 composition only, but favor the analysis of the influence specific company characteristics
535 exerts on this performance across the study period.

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6. CONCLUSIONS

Many studies that adopted three-level hierarchical modeling with repeated measures, in which the third level represented the country of origin effect, found significant variability among companies from different countries. Among these, the study by Goldszmidt, Brito and Vasconcelos (2007) deserves special attention, carried out in Brazil with data from a sample of Compustat Global. In the present research, on the other hand, the absence of significant variability at the third level may be due to the fact that all companies were operating in Brazil, with only some being owned by foreign capital. This phenomenon can be affecting the companies' performance homogeneously, in function of the characteristics present in the country, such as tax burden, interest rates or credit acquisition mechanisms, which evidences the absence of a differentiated profitability increase by multinational companies operating in Brazil.

The contribution to the hierarchical modeling study allows the researcher to assess important nuances in longitudinal databases. However, the technique is limited by the determination of the research question, which should be defined according to the natural hierarchical structure of the data and to the logic the software works with. If, on the one hand, the data structure needs to be nested in hierarchical levels, on the other, missing or censored values are permitted, without the need for data balancing, like in other techniques such as structural equations (SHORT, KETCHEN Jr., BENNETT and du TOIT, 2006, p. 259-286).

Another contribution of the study refers to the estimation of the impact the time variation exerts on companies' performance, as well as among firms. Many authors have structured studies in this line, granting the researchers a possibility to prioritize aspects deserving greater attention. If the country effect is stronger, then the focus on the impacts related to the differences among countries for performance composition should also be. If, on the other hand, the differences among firms explain the largest part of the variance, like in this study, then the focus on strategic management and differences among organizations is stimulated.

The third contribution of this study is the addition of predictive variables at firm level. Many studies look at the decomposition of variance, however, without assessing the impacts deriving from the presence of certain variables, merely aiming to determine where the largest part of the variability occurs (RUMELT, 1991, p. 167-185). According to Short, Ketchen Jr., Bennett and du Toit (2006, p. 25-284), the applications with linear hierarchical models offer the researchers new possibilities of testing more complicated hypotheses without the risk of violating the premises inherent in other techniques, such as regression by the ordinary least squares method.

Other approaches deserve further study with respect to companies operating in Brazil. The inclusion of predicting variables, such as the existence of corporate universities for example, financial and institutional stimulation for professionals to take external courses and efficiency of internal training programs, can be stimulated to determine new strategies and create different models, with a view to a deeper understanding of the factors ruling companies' performance over time.

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