



Global Advanced Research Journal of Management and Business Studies (ISSN: 2315-5086) Vol. 4(3) pp. 127-136, March, 2015  
Available online <http://garj.org/garjmbs/index.htm>  
Copyright © 2015 Global Advanced Research Journals

*Full Length Research Paper*

# Investibility determinants: empirical evidence to the Brazilian cities selected for the period 2002-2012

Antônio S. B. da Silva<sup>1\*</sup>, Carla S. E. Marques<sup>2</sup>, Fred L. Siqueira Campos<sup>3</sup> and Ana Clara Barbieri<sup>4</sup>

<sup>1</sup>Faculdade de Ciências Sociais Aplicadas do Sul de Minas (FACESM)

<sup>2</sup>Universidade de Trás-os-Montes e Alto Douro (UTAD)

<sup>3</sup>Universidade Federal de Itajubá (UNIFEI)

<sup>4</sup>Faculdade de Ciências Sociais Aplicadas do Sul de Minas (FACESM)

Accepted 27 February 2015

Currently, the movements in the foreign direct investment (FDI) are quite complex and they are linked to a number of factors that surround the competitive environment in which firms operate, and to economic characteristics of recipients and senders places, being an object of study of several researches, such as Amal, Seabra e Sugai (2007); Piteli (2009); Genvilaité (2012); Figini e Görg (2011); Ramstetter (2011); Kim e Park (2012), and others. The aim of this study is to contribute to the analysis of investibility determinants, estimating the main determinants of the flows of foreign direct investment (FDI) on the Brazilian group of cities (São Paulo, Rio de Janeiro, Salvador, Fortaleza, Belo Horizonte, Manaus, Curitiba, Recife, Porto Alegre and Belém) for the period 2002-2012. From the linear mixed-effects model and the Stepwise variables selection method it is suitable to highlight, among the 135 independent variables verified, the public revenues and expenditures, the large companies and the amount of natural resources as main investibility determinants of the group of studied cities.

**Keywords:** Investibility, FDI determinants, Brazilian selected cities, Linear mixed-effects model.

## INTRODUCTION

The optimization in the use of the resources to invest is a decisive factor for the growth of a place. The knowledge of external conditions to the company or to the governmental body is an important variable to economic decision-making and fundamental in periods of low cycles (economic crisis), being the company or the government the agent of the decision.

Kotler (2007) affirms that places compete with each other in three interdependent dimensions. The first of them is called investibility (The other two dimensions, not

approached in the study, are habitability and visitability). This one is the ability of the place to attract investment, maintain a propitious environment and favorable to business in general and sustain comparative advantages upon one or more productive complexes, activities or economic sectors in which the place is eventually specialized. Such concept represents the basis of this current study. The level of FDI inflows of the investigated places has been used as proxy variable for investibility.

It is understandable that the knowledge of exogenous conditions over the economic agents can be obtained (prominently through statistic model) and that, it is still feasible to study the degree of association between the level of investment (investibility) and the variables which

\*Corresponding Author Email: [suerlilton@hotmail.com](mailto:suerlilton@hotmail.com)

promote such investment. Through the knowledge of these variables, local authorities can structure a plan of action to increase their economic capacities and, thereby, attract investments and achieve higher goals for growth to their own cities. Such knowledge will allow authorities to act and manage their resources in a more efficient way.

This research has as its general objective contribute to the analysis of FDI determinants of a local, but in a more specific and unprecedented way, which is: to estimate, from a group of available variables and/or signaled by economic literature (from the use of the methodology of panel data), the main determinants of investibility, in the set of Brazilian cities (São Paulo, Rio de Janeiro, Salvador, Fortaleza, Belo Horizonte, Manaus, Curitiba, Recife, Porto Alegre and Belém) for the period 2002-2012.

To this end, it was emphasized six specific objectives to be investigated: 1) raise variables that, previously, are influential to the level of investibility (dependent variable) of the analyzed places, quoted by economic literature. Examples of these variables are: infrastructure; stock of human capital; transportation costs; number of patents, etc. 2) raise which variables are influential to the level of investibility, but supported only by empirical evidence (the main contribution of this thesis). City revenues and expenditures, number of large companies and medium-sized enterprises, credit operations, domestic saving, domestic investment, etc., are examples of these variables; 3) establish, from a secondary research (Given the emergence of factors (most of them exogenous) which interfered in the collection of necessary variables to the present study, we tried to minimize these occurrences by, for example, using proxy variables), beside official bodies from municipal, state and federal governments, the referent values to each one of the selected variables; 4) define, if necessary, proxy variables for some investibility conditions; 5) build the matrix of results (with the  $n$  variables in the  $m$  periods for the set of studied cities; 6) obtain, after statistic treatment (mixed-effect linear regression analysis), the predictors of investibility in the set of studied cities.

## FOREIGN INVESTMENTS

The foreign investments can be classified in direct investments or portfolio investments. Portfolio investments correspond to the capital flows which are not guided for operational control of the recipient firm, in other words, it means investment from non-resident in the financial and capital market of the country (portfolio). On the other hand, direct investment or foreign direct investment (FDI) appoints an investment that aims to acquire a permanent interest in a firm whose exploitation occurs in another country, with the objective of influencing effectively in the management of the firm in

question, according to the International Monetary Fund [IMF] (1999).

For the Organisation for Economic Co-operation and Development [OECD] (2011) foreign investment is considered direct when it represents a capital share of, at least, 10%, and the direct investor has the power of influencing upon the management of the recipient firm. So, one of the main characteristics of FDI is that the foreign investor possesses total or partial control of the enterprise who has received the capital. Differently from portfolio investment, the FDI assets present low liquidity (Amal, Seabra and Sugai, 2007).

The terms of permanency of this investment category tend to be long by its own objective of constituting or sharing productive enterprises, whose maturation is as much undefined as the lifetime of a firm. The incertitude about the time for return and profitability of the invested capital obviously distinguishes FDI as a risky investment (Hennings, 1998; Amal, Seabra and Sugai, 2007).

## Hymer's and Dunning's theories about foreign direct investment

In his work, entitled *The international operations of national firms: a study of direct foreign investment*, Hymer (1976) (Although publicated only in 1976, Hymer's theory was result of his thesis, defended in 1960) isolated the FDI theory from the classical theory of trade and the financial theory, once the interest rate differential would not be the determinant factor to the international investment. The multinational company (MNC) was seen, by Hymer, as an institution dedicated to international production and not for international trade, basing the analysis focus of the MNC in the industrial organization theory. In this way, the industrial organization theory represents a paradigm shift with respect to the approach of the FDI determinants.

While the capital theory (Tobin, 1958; Markowitz, 1959) and the international trade theory (Corden, 1974; Hirsch, 1976) had as their central focus of analysis the reasons that had led companies to produce abroad, the industrial organization theory looked for formulating a conceptual and theoretical framework and evaluating the conditions under which some markets will be attended by foreign subsidiaries of production, instead of being attended by their own local firms or through importation. In other words, while the traditional model of investment assumes that the investment flows are determined by their return differential, the FDI modern theory tries to explain, initially, what determinates the internationalization of the production.

In accordance with Hymer (1976), the foreign firms needed to possess some privileges to operate internationally, such as: patents, specific products, better technical knowledge, greater financing easiness, among others, to compete effectively with local firms. The

appearing of such advantages would involve the existence of some kind of structural market failure.

In his thesis, Hymer (1976) analyzed the advantages and disadvantages of the MNC's actuation. As advantages, the multinational companies utilize their access to international markets of goods and services, as well as their access to technology, to contribute to the world economic integration, in addition to act as a substitute of imperfect markets, sharing effectively the products and factors in the world. On the other hand, these same companies could provoke serious economic problems by eliminating the competition, and put severe policy problems by concentrating the decision-making power and financial power.

Otherwise, if MNCs can compete with local firms, which have greater knowledge of the market and the local environment, it is because they present some kind of compensatory advantage given by product differentiation, access to patented or own knowledge, discrimination in the access to capital or to capacitation differences (imperfect competition); internal or external economies of scale, including those given by vertical integration; governmental intervention, like restrictions to imports.

In general terms, Hymer's contribution (1976) was to conclude that direct investments provide a level of control upon international activities and permit, in this way, to reduce risks noticed by the investor about operate in external markets. Because of this, the concept of ownership advantage is one of the most exploited by theorists after Hymer.

Even though recognizing the importance of MNCs in the process of international investment, Dunning (1973) proposes an integrated formulation of the several determinants of FDI. Dunning's model is also called eclectic paradigm, in so far as may include several competing theories, without exposing a single forecast.

Considered by many critics as a framework and not as a theory, Dunning eclectic paradigm or OLI framework (Ownership, Location, Internalization) is supported by an expressive number of recognized authors from international literature (Hennart, 1982; Anderson and Gatignon, 1986; Kogut and Zander, 1993; Woodcock, Beamish and Makino, 1994). Such paradigm presented three kinds of forces to the companies in the insertion of their activities in the international market, namely: 1) advantages of the privileged property (Ownership) of some assets, tangible and intangible, such as, market power, entrepreneurial skills, marketing, organizational systems, etc.; 2) internalization advantages (Internalization) of certain assets, in other words, the firm added value to its asset internalizing it instead of selling it in the market; 3) Localization advantages (Location) which firms ensured by directing their production for a particular country, such as advantages related to laws

and governmental policies, market structures, institutional, political, legal and cultural environments, etc. Admitting these three forces, the firm should also consider that the external production was consistent with a long-term management strategy. According to Dunning (2001), it is the existence of this set of advantages and the capability of exploiting it that motivates firms to accomplish direct investments in foreign markets.

Besides the eclectic paradigm, Dunning (1993) also presented the reasons for the firm operating in the international market, namely: i) the search for resources, once the firms usually invest abroad in order to acquire specific resources non-available in the domestic market, such as natural resources (Natural resources represent donations in nature utilized in the productive process. They represent the most varied shapes and uses, such as the lands utilized in agriculture; the energetic resources utilized by machines and vehicles, the material resources such as minerals and food; among others. There is no economic activity which is not involving natural resources. These resources can be thought of like a form of capital, known in literature as "natural capital" (HOCHSTETLER, 2002)), raw materials, cheap manpower, etc.; ii) the search for markets, which is why firms invest many times in a country, aiming to offer goods and services to that market. The size of the market and the possibility of its growth are the main reasons for this foreign investment; iii) the search for firm's efficiency. By efficient dispersion of their activities, the MNCs can obtain gains due to the presence of scale and scope economies and the diversification of risk; iv) the search for strategic assets would be an alternative to MNCs engage in activities beyond their original country. Firms usually acquire assets from foreign corporations to sustain or reinforce their own external competitiveness and weaken their competitors. Furthermore, MNCs expect that the merger or acquisition of assets bring benefits to the organization as a whole.

Each one of the reasons listed above corresponds, respectively, to each one of the following classifications: (i) *resource seeking*; (ii) *market seeking*; (iii) *efficiency seeking*; and (iv) *strategic assets seeking*. In all of these cases, a different set of variables will influence the choice of the foreign direct investments' location, according to Dunning (1993).

Under such analytical perspective, the competitive advantage of certain location has been seen, traditionally, in terms of macroeconomic conditions. Factors like size and growth of the market, availability of the labor factor and its costs, inflation levels and external debt and the situation of the balance of payments have always been considered as the main indicators of the level of attractiveness of the location for projects of international investment and trade.

## **Empirical studies about determinants of foreign direct investment**

In terms of recent empirical evidences, there are many studies concerning FDI's impact, some of them exposed in this point of the paper.

Stefanovic (2008) points out FDI importance as a key-factor of economic development and cornerstone of capital flows. The OLI framework (Dunning's eclectic paradigm) sustains the analysis of this study. It starts from the conviction that MNCs are owners of specific advantages (ownership), and that they will have capability of internalizing the transaction costs (internalization). So, the most important factor on FDI decision-making will take into account the advantages of localization (location) of the host country. Among the possible location advantages, the study points to institutional factors, that elapse from FDI policies adopted by a country, as key-elements in the FDI option.

Raziq and Perry (2012) discuss broadly the negative evaluation of New Zealand government concerning foreign investment and foreign acquisitions. These authors try to evaluate the role of FDI, as well the politics of New Zealand government related to foreign investment. Data on investments abroad were analyzed, they were obtained through Overseas Investment Office, in New Zealand, from January 2000 to December 2010. Raziq and Perry (2012) also discuss the historicity, contemporaneity, and governmental policies of FDI in New Zealand. They suggest that FDI has been performing an important role in New Zealand economy, what does not justify a negative evaluation. Over the years, foreign investments have been characterized by acquisitions/foreign ownership of assets in New Zealand, but mainly by foreign ownership. The study's recommendations for New Zealand government agencies are in the sense of motivate, increasingly, the policies of foreign investment attraction.

Kim and Park (2012) explore a set of bilateral international data established throughout the period 1963-1998 to investigate the relation between FDI and manpower from abroad, in a FDI host country. Workers trained abroad acquire specific human capital from that country, more productive in the country which promoted such education. The more stock of local manpower trained in a specific foreign country, the more investment in technology by the foreign subsidiary in the country in question, once it can make use of this manpower, in a more productive way due to specific human capital from the country which promoted education. Consistent with the empirical results, Kim and Park (2012) show that manpower trained abroad was responsible for a considerable share of the growth of FDI inflows.

Great part of theoretical literature concerning FDI and MNCs had the firms as main focus of analysis, seeking to identify the advantages which they should possess to get into the international market and be able to compete with

domestic firms. Minor importance was given to macroeconomic factors.

In relation to empirical studies related to FDI determinants, we verified that in great part of them, traditional factors such as GDP level, its growth rate, market size, openness degree, labor costs, etc., are the main influences of foreign investments, above all, in developing countries. And more, FDIs are conditioned in these countries, most of the time, by the search of markets (resource market) and sources (resource seeking). However, the sensibility of these foreign capitals to domestic and foreign factors to the host economy can change basically due to the sort of FDI.

## **MATERIALS AND METHODS**

Hsiao (2003) asseverates that the models for panel data (longitudinal studies) give a number of advantages in relation to cross-section models or time-series, one of them refers to the fact of these models control the heterogeneity alive in the individuals (in this thesis, in the cities). Another advantage relies on panel data, which permit the use of more observations, increasing the number of freedom degrees and decreasing the collinearity between explanatory variables. It is known, when multicollinearity exists, that is difficult to establish if an individual regressor influences or not the answer variable. Once eliminated the problem, an improvement in the quality of parameters estimation can be obtained.

Moreover, panel data are able to identify and measure effects which are not possible of being singly detected by data analysis through cross-section or time-series. However, panel data possess some limitations. According to Hsiao (2003), as variables are analyzed in time, panel data require a great number of observations thus they are more difficult to be implemented.

### **Linear mixed-effects model**

A usual approach to longitudinal data analysis relies on linear mixed-effects models (Laird and Ware, 1982). In these models the underlying assumption is that some subset of the regression models can vary among individuals, taking into account, therefore, natural resources of heterogeneity in the population. So, individuals in the population have their own specific average path over the time and a subset of regression coefficients is considered random. The distinguishing feature in the linear mixed-effects models is that the average answer is modeled as a combination of the population characteristics which are shared by all of the individuals, and specific effects, unique to each individual. The first effects are called by fixed and the last ones by random. The term "mixed" is used in this context to name the model containing both fixed and random

effects.

A very attractive aspect of this model is its flexibility in accommodate any degree of unbalance in longitudinal data, beyond its ability to take into account the covariance between repeated measures in a relatively parsimonious way. Thus the mixed-effects model does not require the same number of observations in each individual nor that measures be taken in the same set of occasions. The incorporation of mixed-effects models does justice to the quality and cost of longitudinal studies. Furthermore, the dependence among the repeated measures, the use of unbalanced data and lacking observations, make necessary the use of a kind of model able to deal with such characteristics.

The linear mixed model is given by:

$$Y_i = X_i\beta + Z_i b_i + \varepsilon_i \quad i = 1, \dots, n; \quad (3.1)$$

where  $Y_i$  is the vector of answers of the  $i$ -*nth* individual, of dimension  $n_i \times 1$ ;  $X_i$  is a known matrix, of dimension  $n_i \times p$ , which makes connection between  $\beta$  and  $\beta e y_i$ ;  $\beta$  is the vector of fixed effects, of dimension  $p \times 1$ ;  $Z_i$  is a matrix of known covariates, of dimension  $n_i \times q$ , which makes connection between  $b_i e y_i$  and  $b_i e y_i$ , being  $Z_i$ , a subset of  $X_i$ ;  $b_i$  is a vector of random effects, of dimension  $q \times 1$ ;  $\varepsilon_i$  is the vector of random errors, of dimension  $n_i \times 1$ ;  $n_i$  is the number of observations done in the  $i$ -*nth* individual;  $n$  is the number of individuals in the sample;  $p$  is the number of parameters and  $q$  is the number of random effects.

The usual assumptions of the model (3.1) are:

$$\varepsilon_i \sim N(0, E_i), \quad b_i \sim N(0, B)$$

$$\text{Cov}(b_i, b_{i'}) = 0, \quad \text{Cov}(\varepsilon_i, \varepsilon_{i'}) = 0 \text{ to } i \neq i',$$

and  $b_i$  and  $\varepsilon_i$  are accepted independently. As consequence of linear mixed model (3.1), we have that:

- $E(Y_i) = X_i\beta = \mu_i$
- $\text{Var}(Y_i) = Z_i B Z_i' + E_i = V_i$
- $\text{Cov}(Y_i, Y_{i'}) = 0 \text{ to } i \neq i'$ .

As  $Y_i$  is a linear combination of  $b_i$  and  $\varepsilon_i$  we have that  $Y_i \sim N(\mu_i, V_i)$ . The model (3.1) can be simplified when  $E_i = \sigma^2 I_i$ , where  $I_i$  is a identity matrix of  $n_i \times n_i$ . When it happens, the model is called by *conditional independence model*, because when conditioning the  $n_i$  answers of the  $i$ -*nth* individual to the vectors  $b_i$  and  $\beta$ , the become independent. When the amount of measured observations is the same to all the individuals and in the

same condition ( $n_i = m, \forall i = 1, 2, \dots, n$ ) is considered that the model presents balanced data in relation to the number of observations, otherwise, the model has unbalanced data.

As much as the observations in different individuals are considered independent, the matrix of variance-covariance of all the observations is a diagonal block, of dimension  $\sum_{i=1}^n n_i \times \sum_{i=1}^n n_i$ , in the general case (which permits to accommodate unbalanced data) and the diagonal block of dimension  $m \times m$  in the case of unbalanced data, each block being at  $V_i$ .

In the next Chapter we estimated a model to identify and evaluate the relevance of the variables that determined the level of investibility of the set of selected cities for this study, in the period 2002-2012.

## RESULTS FOR THE REGRESSION APPLIED TO THE CONDITIONINGS OF INVESTIBILITY OF THE SELECTED CITIES

The Mixed-Effect Linear Regression Model (Fitzmaurice, Laird and Ware 2011) was used to identify among the 135 independent variables those which influenced significantly the values of *investibility*, making possible to consider, in the inference, the existing dependence in the measures of each city over time.

And, still, when inserting a random effect in the group level (in our case, cities) there will be a varying-intercept model (Gelman and Hill 2007), that will enable, immediately, to account the dependence existing within each city over time, in the estimation of regression coefficients, thus making the estimates of regression coefficients more efficient, in other words, with less uncertainty.

Considering the logarithm of *Investibility* we have the following model to the  $t$ -*nth* time, with  $t = 1, 2, \dots, 9$  (2002, ..., 2012), and to the  $j$ -*nth* city, with  $j = 1, \dots, 10$  (Belém, ..., São Paulo):

$$\text{Log}(\text{Investibility})_{jt} = X_{jt}\beta + \alpha_j + \varepsilon_i \quad (4.1)$$

Being so:

- $\text{Log}(\text{Investibility})_{jt}$  is the model's independent variable;

- $\alpha_j \sim N(0, \sigma_\alpha^2)$ , with  $j = 1, 2, \dots, 10$  cities – it is the random effect following a normal distribution with zero average and variance  $\sigma_\alpha^2$ . In order to explain the heterogeneity among cities as well as the present correlation in the measures of the same city over time we assigned it to them;

- $\varepsilon_i \sim N(0, \sigma_\varepsilon^2)$ , with  $i = 1, 2, \dots, 90$  observations – it is the random error of the regression, following a normal distribution with zero average and variance  $\sigma_\varepsilon^2$ .

Everything unexplained by the model goes to this

**Table 1.** Potential predictors for the multivariate model

<i>log</i> (Pop.)	<i>log</i> (Intergov. Trans. State)	PSCDA Oth. Exp. Out. Staff
<i>log</i> (Bud. Rev.)	IPI Exportation Quota	<i>log</i> (IDB)
<i>log</i> (Curr. Rev.)	Cov. Trans.	<i>log</i> (OCE)
<i>log</i> (Tax Rev.)	Cov. Trans. Un.	OCEDA Fin. Aid Stud.
<i>log</i> (Taxes)	<i>log</i> (Pen. and Int.)	OCEDA Cons. Mat.
<i>log</i> (IPTU)	<i>log</i> (Act. Debt Rev.)	<i>log</i> (Capital Expenditures)
<i>log</i> (ITBI)	<i>log</i> (Misc. Rev.)	<i>log</i> (Investments)
<i>log</i> (ISSQN)	Amort. of Loans	Debt Amortization
P. P. Fee	Cap. Trans. of Priv. Inst.	<i>log</i> (Vehicle Fleet)
factor(Bem. Charges)	Cap. Trans. Cov.	<i>log</i> (Infrastructure)
<i>log</i> (Patr. Rev.)	Cap. Transf. Cov. of the Un.	Educat. Infrast.
Sec. Rev.	<i>log</i> (Bud. Exp.)	<i>log</i> (GDP)
C. P. Rev.	<i>log</i> (Curr. Exp.)	Transp. Costs
<i>log</i> (Curr. Trans. Rev.)	<i>log</i> (PSC)	<i>log</i> (Stock Hum. Cap.)
<i>log</i> (Curr. Intergov. Trans.)	<i>log</i> (PSC Dir. App.)	Innovation
Intergov. Trans. Un.	PSCDA Pensions	<i>log</i> (Entrepreneurship)
IOF Gold Quota	PSCDA. Fam. Wage	<i>log</i> (Medium Enterp.)
Oil Quota	<i>log</i> (PSCDA Mat. Civ. Per.)	<i>log</i> (Large Comp.)

Source: Based on empirical research made by the author (2014).

component;

- $X_{jt}$  is the matrix of independent variables of dimension 90 xp, “p” as the number of inserted variables in the model; and  $\beta$  represents the fixed effects assigned to each independent variable.

$$X_{jt} = \begin{bmatrix} 1 & X_{(1)1,1} & - & X_{(135)1,1} \\ 1 & X_{(1)1,2} & - & X_{(135)1,2} \\ | & | & | & | \\ 1 & X_{(1)10,9} & - & X_{(135)10,9} \end{bmatrix} \quad \beta = \begin{bmatrix} \beta_0 \\ \beta_1 \\ | \\ \beta_{135} \end{bmatrix}$$

We must have in mind that the matrix of independent variables has dimension 90x136, once we have 90 observations and 135 independent variables. In possession of such number of variables, it is important to apply a method to select them, to find the best subset of independent variables which explain the variation of *Log(Investibility)*. We applied the Stepwise method to do so.

The Stepwise method is one of the most useful methods to select variables in regression analysis; it is a mix of Backward and Forward methods. The Backward method is an algorithm which starts the regression model with all the independent variables, removing the variable with the highest p-value. The procedure is repeated until significant variables remain in the model, at a specific level of significance. In opposition, the Forward algorithm starts the regression model without any independent variable and adds the variable with the lowest p-value; this procedure is repeated until there are no more significant variables to add. Efroymson (1960)

presented the Stepwise method for the first time.

In this study we used bivariate regressions as entry criteria in the multivariate model (Forward method), thus promoting a set of potential predictors. We used a degree of 15% of significance in the bivariate regressions to select the potential predictors. The Backward algorithm was applied over the multivariate model, in a degree of 5% of significance with all the potential predictors.

We made use of residual analysis to check if the underlying suppositions in the adjusted model were relevant. Through histogram and QQ-plot, we verified the residual normality among the set and the random effects. The test of normality of Shapiro and Wilk (1965) was done to confirm the supposition of normality.

To check the homoscedasticity and adequacy of the average structure, we made use of the graph of standardized residuals versus the predicted values; to check the independence of errors, we made the empirical autocorrelation function within sets. We made use of the software package R version 2.15.0.

### Selecting the potential predictors: Forward method

In order to select the potential predictors to the multivariate model, we performed a bivariate regression to each one of the 135 independent variables. From the results, we selected the variables with p-values lower than 0.15. These predictors are in Table 1 above.

As mentioned, we applied the Backward algorithm over the potential predictors in a degree of significance of 5%, thus creating the multivariate model (Stepwise model) presented next.

Table 2. Stepwise Model for log (Investibility)

Stepwise Multivariate Model	B	S. E. ( $\beta$ )	P-value
Intercept	813.29	67.11	0.000
Years	-0.410	0.035	0.000
$\log(\text{Rec. Orç.})$	2.249	0.404	0.000
I OF Gold Quota/100.000	-0.305	1.243	0.017
Oil Quota/1.000.000	0.102	0.042	0.017
$\log(\text{Pen. Int.})$	-0.458	0.104	0.000
$\log(\text{PSC Dir. App.})$	-0.928	0.308	0.004
PSCDA Pensions/1.000.000	0.006	0.001	0.000
OCEDA Fin. Aid. Stud./1.000.000	-0.106	0.041	0.013
Educat. Infrast./100	-0.035	0.010	0.001
$\log(\text{Large Comp.})$	2.318	0.422	0.000
Source of Variation	Variance	% Variance	S. D.
Inter-City	0.037	22.9%	0.192
Intra-City	0.124	77.1%	0.352

Source: Author (2014).

### Multivariate Model (Stepwise Model)

Applying the Backward algorithm, in a degree of significance of 5%, the result was the multivariate model presented below.

#### $\log(\text{Investibility})$

$$\begin{aligned}
 & -813.3 - 0.41\text{Years} + 2.25\log(\text{Bud. Rev.}) - 0.305\frac{\text{IOFGoldQuota}}{100,000} + 0.10\frac{\text{OilQuota}}{1,000,000} \\
 & - 0.46\log(\text{Pen. Int.}) - 0.93\log(\text{PSCDir.App.}) + 0.006(\text{PSCDAPensions}) \\
 & - 0.106\frac{\text{OCEDAFin.AidStud.}}{1,000,000} - 0.035\frac{\text{Educ. Infrast.}}{100} \\
 & + 2.32\log(\text{LargeComp.}) + \alpha_j + \varepsilon_i
 \end{aligned}$$

After adjusting the mixed-effects regression, through Stepwise algorithm in the selection of variables, we can verify that, *ceteris paribus*:

- During 2002 and 2012, each one-year passing by the average value of *investibility* decreases 33.6% ( $e^{-0.41}$ );
- Each 1% increased in “Bud. Rev.”, the average value of *investibility* increases at an average of 2.25%;
- Each 100.000 units increased in “I OF Gold Quota”, a decrease of 26.3% ( $e^{-0.305}$ ) in the average value of *investibility* is expected;
- Each 1.000.000 units increased in “Oil Quota”, a increase of 10.7% ( $e^{0.102}$ ) in the average value of *investibility* is expected;
- Each 1% increased in “Pen. Int.”, the average value of *investibility* decreases at an average of 0.46%;

- Each 1.000.000 units increased in “PSCDA Pensions”, an increase of 0.6% ( $e^{0.006}$ ) in the average value of *investibility* is expected;

- Each 1.000.000 units increased in “OCEDA Aid. Fin. Stud.”, a decrease of 10% ( $e^{-0.106}$ ) in the average value of *investibility* is expected;

- Each 100 units increased in “Educ. Infrast.”, a decrease of 3.4% ( $e^{-0.035}$ ) in the average value of *investibility* is expected;

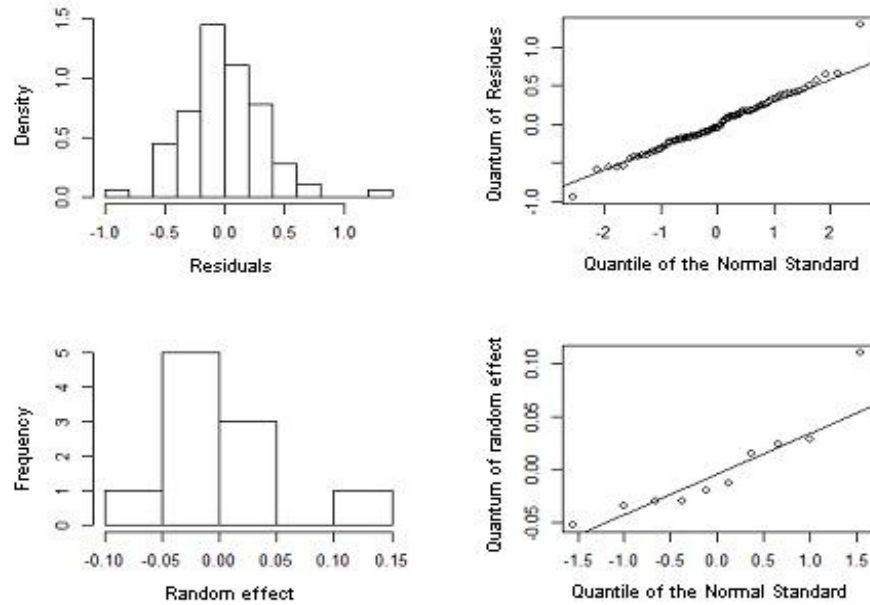
- Each 1% increased in “Large Comp.”, the average value of *investibility* increases at an average of 2.32%.

According to Equation (4.1), the random effect is given by  $\alpha_j \sim N(0, \sigma_\alpha^2)$  and the regression error within the city by  $\varepsilon_i \sim N(0, \sigma_\varepsilon^2)$ . Thus the final model estimated

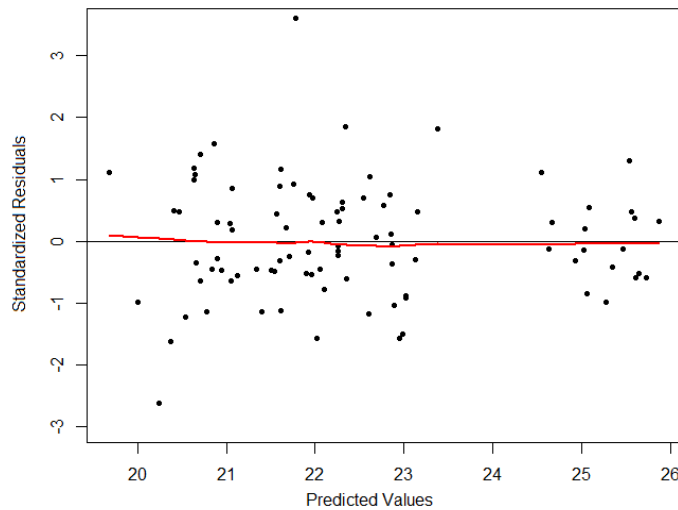
$\sigma_\alpha^2 = 0.037$  and  $\sigma_\varepsilon^2 = 0.124$ , so the accuracy of new estimations of  $\log(\text{investibility})$  within the city already considered in the analysis is  $\pm 0.352$  ( $\sqrt{0.124}$ ), while for new estimations of  $\log(\text{investibility})$  considering new cities, the accuracy is  $0.401$  ( $\sqrt{0.037 + 0.124}$ ).

Controlling by all the variables included in the final model, of total variance of the model, 77.1% occurs within the cities, that means a larger error to new cities in inferences to new years. This information is condensed in Table 2 above.

The residual analysis is made in the topic below.



**Graph 1.** Histogram and QQ-plot for residuals and random effects  
Source: Author (2014).



**Graph 2.** Standardized Residuals *versus* Predicted Values  
Source: Author (2014).

**Residual Analysis**

In accordance with Pinheiro and Bates (2000), before inferring about the adjusted linear mixed model we must check whether the underlying suppositions are valid. There are two relevant suppositions in linear mixed models:

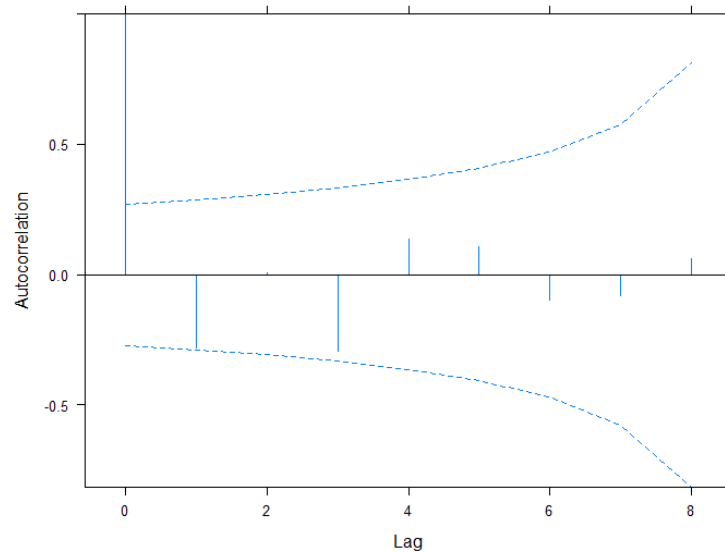
- 1<sup>st</sup> supposition: The within-group errors, in this case, the cities, are independent, equally distributed, zero average and variance  $\sigma_{\epsilon}^2$ , and independent of random effects as well.

- 2<sup>nd</sup> supposition: The random effects are normally distributed with zero average and variance  $\sigma_{\alpha}^2$ .

Graph 1 Above shows us that there are no strong evidences of residuals within groups and normal distribution of random effects. To verify the normality of residuals within groups and of the random effects, we performed Shapiro’s test, which presented the p-values 0.073 and 0.081. So, the supposition of errors normality and random effect was not violated.

We can see in Graph 2 that the residuals are randomly distributed around zero, indicating the inexistence of





**Graph 3.** Empirical autocorrelation function of residuals within cities  
Source: Author (2014).

evidences for heteroscedasticity of residuals within groups. The lack of standards in this graph shows also that the structure of the average is not specified, thus highlighting the importance of working with logarithmic transformation in the dependent variable, such as in the independent ones which were part of the Stepwise model.

In Graph 3, there is the empirical autocorrelation function of residuals within sets, where can be observed that there are no significant lags of the autocorrelation function, thus, not generating dependence evidences.

In short, the results show that, during 2002-2012, the set of variables which explains better the relations of *investibility* in the studied cities was, according to Table 2, Budget Revenues –  $\log(\text{Bud.Rev.})$ ; Natural Resources – proxy variable  $\text{OilQuota}/1,000,000$ ; payment of pensions; and the number of large companies.

In reverse of this attraction there are: IOF/Gold quota, the collection of penalties, interest and late payment, financial aid for students, direct applications and educational infrastructure.

Concerning traditional factors such as GDP, innovation, human capital, infrastructure and population, which predict foreign direct investment in most of the empirical studies at country level, here, they apparently affect *investibility* as well, but in a bivariate way (Table 1). However, in a multivariate way, only the final set (Table 2) was significant, considering the Stepwise method in the selection of variables.

It is also true for some variables put in test, first in this thesis, which result is in Table 1. They are (all measured at city level): population; GDP; stock of human capital; innovation; entrepreneurship activity; infrastructure; medium enterprises; large companies; revenues; and expenditures.

Regarding the variation of *investibility* during the analyzed period of interest, the results show that, *ceteris paribus*, the average value of *investibility* decreases 33.6% with each passing year.

When it comes to the accuracy of new estimates of *investibility*, *ceteris paribus*, from the total variance of the model, 77.1% occurs within city, what means that, there is a greater error for new years than for new cities.

## CONCLUSION

Therefore, it is believed that this research has achieved its goal of extend the comprehension about the phenomenon of FDI determinants in more regional locations, in the case of the group of analyzed cities. These cities are more likely to highlight the name of Brazil abroad. Hence, due to the scarcity of studies about the thematic in Brazil, it is believed that this research can be basis for deeper studies.

While we have proposed to subsidize new academic investigations and policy-makers, we believe we have contributed qualitative and quantitatively for a great knowledge and comprehension about FDI determinants in the set of cities of São Paulo, Rio de Janeiro, Salvador, Fortaleza, Belo Horizonte, Manaus, Curitiba, Recife, Porto Alegre e Belém.

The main implication of such study is that the set of variables in use in the statistical modeling – great part of them mentioned in empirical and theoretical literatures as FDI determinants at a country level – were not significant when put in a city view. Being so, we can affirm that beyond these variables other specific ones are taken into account in the foreign investor's decision of allocation of the investment, mainly in continental countries such as

Brazil, which possesses very different regions.

Such diversity corroborates and potentiates its replications (in other cities or regions) providing information which will guide MNCs managers and local governments to make decisions about allocation of resources.

Now, it is fundamental enunciate some of the limitations found in this study in order that future investigations can bring another vision on it, not only about how variables interact among them, but also reflect about what variables can be included and what others scenarios can be explored. For instance, the disposal of variables like subsidies of local government, a longer period of time which could make possible infer about the role and the importance of the management of local governments in analysis, the insertion of other important variables in the discrimination of sets are, doubtless, the limitation of this study, which gives true opportunities to other researches and motivation to other investigators.

## REFERENCES

- Amal M, Seabra F, Sugal R (2007). Análise dos determinantes institucionais e regionais do investimento direto externo das pequenas e médias empresas: um estudo do caso da Região Sul do Brasil. *Textos de Economia*. 10(1): 39-67.
- Anderson E, Gatignon H (1986). Modes of foreign entry: a transaction cost analysis and propositions. *J. Int. Bus. Stud.* 17(3): 1-26.
- Corden WM (1974). The theory of international trade. In J. H. Dunning (Ed.). *Economic Analysis and the Multinational Enterprise*. London: George Allen and Unwin Ltd..
- Dunning JH (1973). *The determinants of international production*. Oxford Economic Papers, 25: 289-325.
- Dunning JH (1993). *Multinational enterprises and the global economy*. Wingham, Berkshire: Addison Wesley.
- Dunning JH (2001). The key literature on IB activities: 1960-2000. In A. Rugman and T. L. Brewer (Eds). *The Oxford Handbook of International Business*. Oxford: Oxford University Press.
- Efroymson MA (1960). Multiple regression analysis. In A. Ralston and H. S. Wilf (Ed.). *Mathematical methods for digital computers*. New York: John Wiley and Sons.
- Figini P, Görg H (2011). Does foreign direct investment affect wage inequality? an empirical investigation. *The World Economy*. 34(9): 1455–1475.
- Fitzmaurice GM, Lair NM, Ware JH (2011). *Applied longitudinal analysis*. New Jersey: John Wiley and Sons.
- Gelman A, Hill J (2007). *Data analysis using regression and multilevel/hierarchical models*. New York: Cambridge University Press.
- Gentvilaitė R (2010). *Determinants of FDI and its motives in Central and Eastern European countries*. Bachelor Thesis, Lunds Universitet, Lund, Sweden.
- Girma S, Görg H, Pisu M (2008). Exporting, linkages and productivity spillovers from foreign direct investment. *The Can. j. econ.* 41(1): 320-340.
- Hennart JF (1982). *A theory of multinational enterprise*. Ann Arbor: University of Michigan Press.
- Hennings K (1998). Uma proposta de modelos para a análise dos fluxos de capitais estrangeiros para o Brasil. *Boletim do Banco Central*. 34(11): 217-255.
- Hirsch S (1976). An international trade and investment theory of the firm. *Oxford Economic Papers*. 28(2): 258-270.
- Hochstetler RL (2002). *Recursos naturais e o mercado*. Tese de Doutorado, Universidade de São Paulo (USP), São Paulo, Brasil.
- Holland M, Barbi F (2010). *China na América Latina: uma análise da perspectiva dos investimentos diretos estrangeiros* [Paper N° 247]. Escola de Economia de São Paulo, Fundação Getulio Vargas, FGV-EESP.
- Hsiao C (2003). *Analysis of panel data*. (2nd ed.). Cambridge, Cambridge University Press.
- Hyme, S (1976). *The international operations of national firms: a study of direct foreign investment*. Ph.D. Dissertation, MIT: MIT Press.
- INTERNATIONAL MONETARY FOUND (1999). Report on the survey of implementation of methodological standards for direct investment. Statistic Department. *DAFFE*. 99(14).
- Kim J, Park J (2012). Foreign direct investment and country-specific human capital. *Economic Inquiry*. 51(1): 198-210.
- Kogut B, Zander U (1993). Knowledge of the firm and the evolutionary theory of the multinational corporation. *J. Int. Bus. Stud.* 24(4): 625-645.
- Kotler P (2007). *Marketing no setor público*. Porto Alegre: Boman.
- Laird M, Ware JH (1982). Random-Effects models for longitudinal data. *Biometrics*, 38: 963-974.
- Lamine KM, Yang (2010). D. Foreign direct investment effect on economic growth: evidence from Guinea Republic in West Africa. *Int. J. Finan. Res.* v. 1, n. 1.
- Markowitz HM (1959). *Portfolio selection: efficient diversification of investments*. New York: Wiley.
- Nonnenberg MJB, Mendonça MJC (2005). Determinantes dos investimentos diretos externos em países em desenvolvimento. *Estudos Econômicos*. 35(4): 631-655.
- ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (2011). Foreign direct investment statistics: notes. OECD, Paris.
- Pinheiro JC, Bates D M (2000). *Mixed-effects models in S and S-PLUS*. New York: Springer.
- Piteli EEN (2009). *Foreign direct investment in developed economies: a comparison between european and non-european countries*. University of Cambridge, Dynamic Regions in a Knowledge-Driven Global Economy - DYNREG, WP. 44. 1-21.
- Ramstetter ED (2011). Ranking locations for Japan's manufacturing multinationals in Asia: a literature survey illustrated with indexes. *Asian Economic J.* 25. 197-226.
- Raziq MM, Perry M (2012). Foreign direct investment in New Zealand: does it justify negative assessment? *Regional Science Policy and Practice*. 4(2):155-164.
- Shapiro SS, Wilk MB (1965). An analysis of variance test for normality. *Biometrika*. 591-611
- Stefanovic S (2008). Analytical framework of FDI determinants: implementation of the OLI Model. *Economics and Organization*. 5(3): 239-249.
- Tobin J (1958). Liquidity preferences as behavior towards risk. *The Review of Economic Stud.* 25(2): 65-86.
- Woodcock CP, Beamish PW, Makino S (1994). Ownership-based entry mode strategies and international performance. *J. Int. Bus. Stud.* 25(2): 253–272.