

# AN ANALYSIS OF INTEGRATION DEGREE BETWEEN MACROECONOMIC AND FINANCIAL VARIABLES THROUGH PRINCIPAL COMPONENTS (2002-2013)

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## Abstract

This work has as its objective to evaluate integration degree of these indexes: Sao Paulo Stock Exchange – IBOVESPA, New York Stock Exchange- Dow Jones, interest rate-SELIC, which fulfills as basic interest rate in Brazil, the civil construction index – CUB and the pricing index to the ample consumer- IPCA, which fulfills as an internal inflation rate in Brazil. The period of analysis was from January 2002 to March 2013. The methodology was principal component analysis (ACP). It shows a high relation degree among SELIC, CUB and IPCA. IBOVESPA and DOW JONES do not present relation with the other variables.

**Keywords:** Interest Rate, Stock Exchange, Principal Components

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## 1. Introduction

Considering the big dwelling lack in Brazil, it is important to have mechanisms that show real state behavior and its relation with macroeconomic variables.

Therefore, this work has as objective to evaluate integration degree of these indexes: Sao Paulo Stock Exchange – IBOVESPA, New York Stock Exchange- Dow Jones, interest rate-SELIC, which fulfills as basic interest rate in Brazil, the civil construction index – CUB and the pricing index to the ample consumer- IPCA, which fulfills as an internal inflation rate in Brazil.

According to Belleza (2001) real state and financial market were on the same track for long time, but they would be invariably when related to loan. Traditionally, banks have been actives in providing loaning either to the producer (constructor/incorporator) or to the final consumer. On the other hand, the investment banks did not have any kind of relations with real state, due to the lack of interest in that business. Among the big Brazilian financial corporations, during many times, the directors of investment bank did not even know the directors of real state credit. However, the situation has started changing. The concept of real state, in which the operation depends on a specific property, started to become business.

During analysis in such area, evaluation involves not only the real value of the property. It involves mainly how much an established business in that property will profit for the next years. It is based on a

study of possible cash flow that the operation will provide in the long-term.

As some of such operations would show quite interesting profitability rates, investors became interested not only in investing on them, but also, in participating in their results. The financial market started to ponder real state either as a governmental bond operation or as a risk asset. Thus, their initial idea of just loan had investment included.

Vedrossi and Shinohara (2001) show that with the end of the dwelling financial system in 1999, the entrepreneur companies started to seek for new ways of loan, either for sources of business production or for its commercialization. A way found by most of the entrepreneurs was the usage of their own sources as loan. It is important to take into consideration that adaptation of production into the buyer's savings capacity is something difficult to figure. Another way was to take resources from financial institutions aiming to adapt its cash to loan for clients. Such way was carried out through mechanisms that were not specifics for real states' loans.

Such operations have extremely non-joined conditions in relation to long-term operations, considering interests and indexes, what reinforces the risk. Therefore, financial agents that are able to stand during the recovery period of allocation of their own resources into real state investments are crucial. Such fact sets the entrepreneur free to reallocate his resources in new projects, focusing in covering the dwelling lack in Brazil.

It is important to characterize investors whose profiles are for long-term investment products, such

as bonds related to real states assets what identifies the eventual demand characterized by those bonds.

Institutional investors, mainly pension funds and insurance companies, form the majority of that group. These investors have the necessity of long-term investments and considerable security, which is provided by the real state.

Besides that group, we can consider a potential demand formed by individual investors who, taking into consideration the real state development, might reallocate their assets into those bonds using a part of savings account.

Accordingly, we can identify the necessity of an institutionalized risk classification of bonds related to real state assets, involving all the characteristics of this business. Such classification would be as a standard for comparisons to other long-run investments.

Despite the fact that Brazilian real state market is in an early stage in terms of financial structure, it is in total development with new searches and experiences, which are mainly related to real state assets security. Such circumstance is due to the present lack of resources for loaning.

The lack of an investment risk classification results in the fact that the CUB index is considered as a thermometer in the civil construction area. Then, it was used in this analysis.

## 2. Brief Historical of the Cub

The CUB (Basic unit cost per square meter of construction) was settled through the law n<sup>o</sup> 4.591 on December 16 1964. Each trade union of the civil construction industry (Sinduscon's) started calculating and publishing until the fifth day of each month several specifications of the basic unit cost per square meter of construction.

According to Goncalves (2002) such cost is calculated based on different representative standard projects (1, 4, 8, 12 floors; 2 or 3 bedrooms; low, regular or high standard finish) taking into consideration materials, labors and equipments with their respective constant weighs, which were previously on the NB-140/64, and at present on NBR-12721/99, from the Technical Standard Brazilian Association – ABNT.

The basic CUB's objective is to control the real state market as basis for cost determination in the civil construction section. It is published monthly and represents a partial cost of the construction; it does not include additional costs such as elevators, special foundations, building installations (water, electricity and sewer), telephone, engineer earnings etc.

Wages, material and equipment prices that are predicted on the NBR – 12721/99, are monthly collected by Sinduscon's through a survey with 20 or more construction companies. Therefore, the survey is carried out according to the buyer's perspective, what eliminates possible misinterpretations especially in

relation to prices provided by distributors/sales people. In agreement with NBR – 12721/99, which predicts one CUB published in currency, its calculation cannot be limited to the verification of the materials' average performance. For each material is necessary an average data that shows truly the real price evolution. Hence, in order to get closer to the effective reality, the market has adopted medium as central trend measure for the unit cost calculation. Besides, all CUB calculations are currently computerized.

Although the basic CUB's objective is to control the real state market in order to have cost price, it has been extremely important for the construction cost evolution. So, as an index, the CUB is trustful in determining average cost performance of the construction section.

## 3. Principal Component Analysis

### 3.1 Purpose and Methodology

Para Verdinelli (2000), the purpose of this analysis is to substitute a group of correlated variables for a group of new variables, which are no correlated. Such variables are lineal combinations of the correlated ones ordered in a way that their variances decrease from first to last.

Considering  $D = d_{ij}$  ( $i = 1, 2, \dots, n; j = 1, 2, \dots, p$ ) the data matrix with  $p$  variables ( $x_1, x_2, \dots, x_p$ ) and whose position  $r$  is the same as the number of variables ( $r = p$ ); it is possible to determine  $y_1, y_2, \dots, y_p$  with the following properties:

1) If each  $y$  is a combination of  $p$  variables  $x$ ,

$$Y_1 = x_1u_{11} + x_2u_{21} + \dots + x_pu_{p1}$$

$$Y_2 = x_1u_{12} + x_2u_{22} + \dots + x_pu_{p2}$$

$$Y_p = x_1u_{1p} + x_2u_{2p} + \dots + x_pu_{pp};$$

2) If the sum of the squares of the coefficients  $u_{ij}$  is as the same as 1.

$$\sum_{i=1}^p (u_{ij})^2 = 1;$$

3) If the lineal combinations of variables are ordered by their variances;

$$\text{Var } y_1 > \text{Var } y_2 > \dots > \text{Var } y_p;$$

4) If the new  $y$  variables are not correlated among themselves.

The main idea is that the first  $k$  new  $y$  variables, which are the principal components, can cope with the most of variability of the original data, allowing not to compute  $(p-k)$  that are less important components.

It is important to mention that this analysis is just a way to get a distinguished and perhaps, a more convenient, method of expressing the same group of results.

Through a notation of matrix, it is also possible to conclude that in order to get the principal components, the data matrix (which is denoted for the letter  $D$  in a generic way and possesses  $p$  variables) must be transformed in another matrix  $F$  of

hypothetical non- correlated variables and whose variance declines from first to last.

In order to get the transformation, D must be postmultiplied by an orthogonal matrix A, whose columns are, in a first type of solution, the normalized auto vectors. Such auto vectors are calculated from the smallest product moment of D matrix.

Then,

$$F_{(n \times p)} = D_{(n \times p)} A_{(p \times p)}$$

The columns of A are ordered in a way that the first one is consisted of p components of the auto vector associated to the greatest value of D'D. The second column corresponds to the auto vector calculated since the second greatest value and successively.

F is recognized as the matrix of factorial scores, while A is the factorial load matrix. Taking into consideration such matrices, it is possible to reconstruct the original data table or approximate it, if the components' numbers or extracted factors are K < p.

Then,

$$D_{(n \times p)} = F_{(n \times p)} A'_{(p \times p)}$$

or

$$D_{(n \times p)} \cong F_{(n \times k)} A'_{(k \times p)}$$

For the second equation, it is possible to indicate the difference between the approximated value and the real one as a matrix of residues E (nxp), which allows completing the model.

#### 4. Empirical Results

Monthly data were collected, which corresponding to Sao Paulo Stock Exchange – IBOVESPA, New York Stock Exchange- Dow Jones, interest rate-SELIC, which fulfills as basic interest rate in Brazil, the civil construction index – CUB and the pricing index to the ample consumer- IPCA, which fulfills as an internal inflation rate in Brazil. The analyzed period was from January 2002 to March 2013.

Data were obtained through the Civil Construction Trade Union, Applied Economic Research Institute and Economatica Software.

This work had as objective to find out the level of integration or relation among those indexes, through the traditional multivariate technique of principal components analyzes. Correlation coefficients were extracted in order to identify a possible interaction among the variables.

Table 1 shows that the majority of the indexes have relatively low correlation coefficients, considering a level of statistical significance of 5%. It is important to mention that those indexes have a tendency to vary with national and international economical elements, as well as with variations of the economy growing rates.

In spite of the fact that positive correlation coefficients were found, whose value varied at the minimum of 7% between Ibovespa and CUB and at the maximum of 70% between SELIC, IPCA and

CUB, it is possible to say that there is an insignificant integration between IBOVESPA and DOW JONES with the other variables.

Also, the principal component analysis was used as an evaluation method of the variable integration level.

Table 2 shows the variance proportion that is explained by the first two principal components, which corresponds to around 76.81% of the total variance for that period.

Through Figure 1, it is easy to observe that there are no variables near the center, what means that the variables might be represented significantly just through the first principal component.

IBOVESPA and DOW JONES have opposite behavior to the other variables. Due to this conflicting reason, the method of varimax-normalized rotation was also used. Such method aims to explain not only the factors but also the analyzed variable's behavior.

Clearly, Figure 2 shows two components of distinguished variables. The first component is formed mainly by SELIC, CUB and IPCA variables. The second component has IBOVESPA and DOW JONES. Since the two components are independent among themselves, it is possible to mention that SELIC, CUB and IPCA variables have independent behavior from IBOVESPA and DOW JONES variables.

On tables 3 and 4 the indexes' contribution with the respective unrotated and normalized rotated factor loadings are highlighted.

Through table 4, we can observe that on the first normalized rotated principal component the variables that most contributed statically are: SELIC,CUB and IPCA with 83,74%, 85,97% and 88,83% respectively. In addition, on the second component just IBOVESPA and DOW JONES have a significant contribution with 89.82% and 88.95% respectively. Finally, through the figures and the tables, it is possible to conclude that the IBOVESPA and DOW JONES indexes are not integrated with the other indexes.

#### 5. Final Considerations

This paper had as objective to evaluate the integration level among IBOVESPA, DOW JONES, SELIC, CUB and IPCA variables. The principal component analyzes was used. Through such approach, it was possible to verify that SELIC, CUB and IPCA variables are integrated in components and present relatively low correlation coefficients. On the other hand, IBOVESPA and DOW JONES behaviors showed to be independent from the other variables' behavior, which form another component.

For further studies, other statistical and econometric techniques are recommended, such as: clusters analysis and causality and multiple correspondence analyses with the intention of testing the efficiency of different methods.

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## Appendix A

**Table A.1** Correlation coefficients among the indexes

VARIABLES	IBOVESPA	DOW JONES	SELIC	CUB	IPCA
IBOVESPA	1.00	0.60	0.13	0.07	0.20
DOW JONES	0.65	1.00	0.20	0.12	0.09
SELIC	0.13	0.20	1.00	0.51	0.70
CUB	0.07	0.12	0.51	1.00	0.70
IPCA	0.17	0.09	0.60	0.60	1.00

**Table A.2** Eigenvalues of the extracted principal components

Components	Eingevalues	(%) Total Variance	(%) Cumulative
1	2.357161	46.53322	47.57352
2	1.503636	31.06789	76.81564

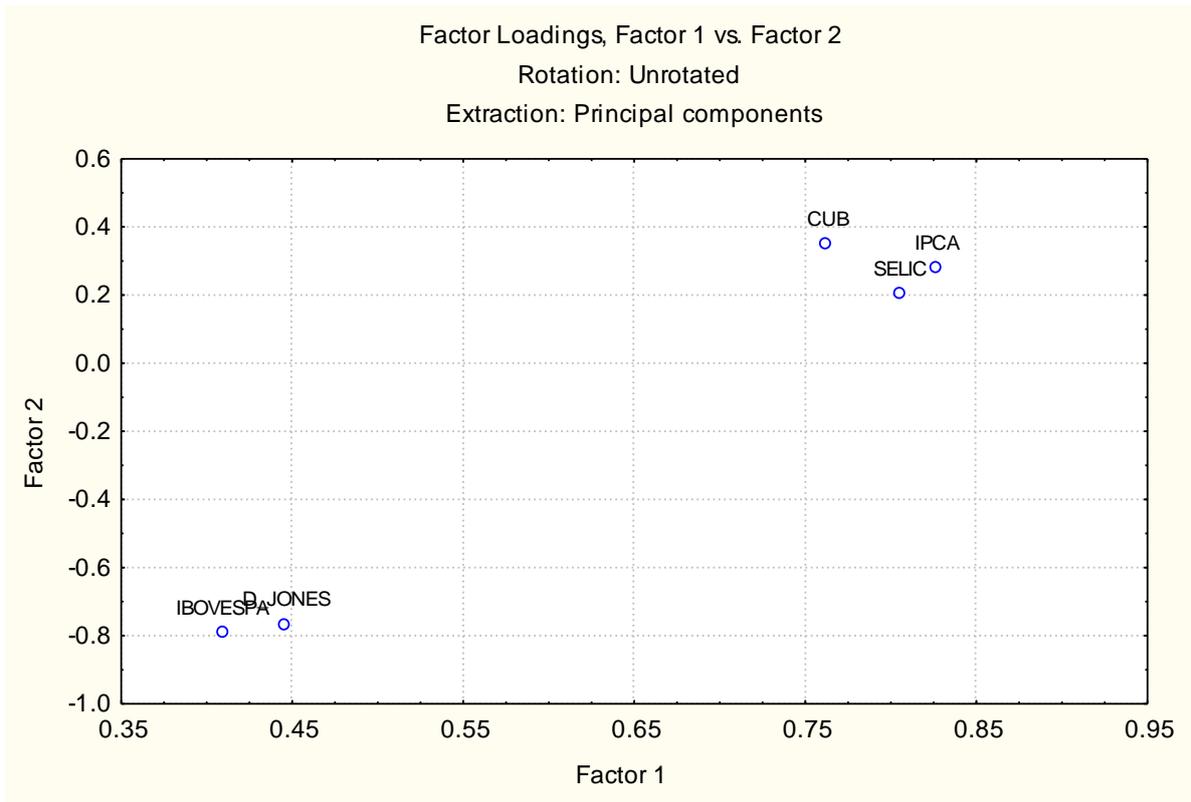
**Table A.3** Indexes' factor loading: Unrotated Principal Components

VARIABLES	COMPONENT 1	COMPONENT 2
IBOVESPA	0.439595	-0.800265
DOW JONES	0.475253	-0.784584
SELIC	0.854358	0.254158
CUB	0.782350	0.382104
IPCA	0.866232	0.320434
EXPL VAR	2.347161	1.473836
PRP TOTL	0.475332	0.330726

**Table A.4** Indexes' factor loading: Varimax Normalized Rotated Principal Components

VARIABLES	COMPONENT 1	COMPONENT 2
IBOVESPA	0.053312	0.898242
DOW JONES	0.083765	0.889556
SELIC	0.837487	0.172215
CUB	0.859793	-0.015020
IPCA	0.888368	0.071344
EXPL VAR	2.179817	1.611173
PRP TOTL	0.477743	0.314145

**Figure A.1** Factor Loading



**Figure A.2** Factor Loading

