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Qualitative assessment of stock prices listed on the São Paulo stock exchange: An approach from the perspective of homogeneity analysis

Evaluación cualitativa de precios de acciones registradas en la bolsa de São Paulo: un enfoque desde la perspectiva del análisis de homogeneidad

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ABSTRACT

The stock market suffers uncertain relations throughout the entire negotiation process, with different variables exerting direct and indirect influence on stock prices. This study focuses on the analysis of certain aspects that may influence these values offered by the capital market, based on the Brazil Index of the São Paulo Stock Exchange (Bovespa), which selects 100 stocks among the most traded on Bovespa in terms of number of trades and financial volume. The selected variables are characterized by the companies' activity area and the business volume in the month of data collection, i.e. April/2007. This article proposes an analysis that joins the accounting view of the stock price variables that can be influenced with the use of multivariate qualitative data analysis. Data were explored through Correspondence Analysis (Anacor) and Homogeneity Analysis (Homals). According to the research, the selected variables are associated with the values presented by the stocks, which become an internal control instrument and a decision-making tool when it comes to choosing investments.

Key words: stock market, multivariate analysis, correspondence analysis, homogeneity analysis.

RESUMEN

El mercado de valores se enfrenta a relaciones inciertas a través de todo el proceso de negociación, con distintas variables que ejercen influencia directa e indirecta en el precio de las acciones. Este estudio se centra en el análisis de ciertos aspectos que pueden influenciar los valores ofrecidos por el mercado de capitales, basado en el Índice Brasil de la Bolsa de Valores de São Paulo (Bovespa), que selecciona 100 acciones entre las más comercializadas de Bovespa en función del número de compraventas y el volumen financiero. Las variables seleccionadas son determinadas por el área de actividad de las sociedades y el volumen de negocios en el mes de la recolección de datos, es decir, abril de 2007. El presente artículo propone un análisis que une el punto de vista de la contabilidad, en lo que se refiere a las variables de precio de las acciones susceptibles de ser influenciadas, con el uso de análisis multivariado cualitativo de datos. Los datos fueron explorados utilizando Análisis de correspondencia (Anacor) y Análisis de homogeneidad (Homals). Según la investigación, las variables seleccionadas se asocian a los valores presentados por las acciones, lo que se convierte en un instrumento de control interno y una herramienta de toma de decisiones cuando se trata de elegir inversiones.

Palabras clave: bolsa de valores, análisis multivariado, análisis de correspondencia, análisis de homogeneidad.

1. INTRODUCTION

In the modern world, it is not unusual for new participants in the economy to invest in stocks. We are witnessing the growing importance and increased interest of the Brazilian population in this risky investment that is marked by constant changes.

The understanding of trends in stock behavior is based on different hypotheses; that is, there are variables exerting direct or indirect influence on the displayed prices.

The need to study the relations between a large set of variables led to the development of multivariate statistical analysis techniques (Fávero, Belfiore, Silva & Chan, 2009). These multivariate techniques specifically serve to identify patterns in sets of multivariate or in univariate data, representing sequences of observations or measurements of a phenomenon. This research provokes relations between variables to which the following techniques will be applied: Correspondence Analysis, followed by Homogeneity Analysis.

Correspondence Analysis starts from a set of methods used for the descriptive-exploratory investigation of large tables, and allows the inclusion of categorical variables, which distinguish it from Factorial and Main Component Analysis. This method also favors the observation of the most important relations in a large set of variables. The results are presented as graphs, in

which the distances between the points drawn show the relations between the variable categories. However, despite its proven utility in studies with complex variables, Correspondence Analysis has not been widely explored in accounting.

Besides reducing a large quantity of information, Homogeneity Analysis makes it possible to acknowledge the relations between the categories and variables. Similarities can be perceived and distinguishing characteristics appointed. The relations are analyzed by locating the values presented by the variables in space, allowing a short comparison of the different existing correlations.

Based on this, and bearing in mind natural Stock Exchange oscillations, this article presents a study based on activity areas and business volume, aimed at verifying whether these variables present a relation of dependence or independence with the stock prices. This is undertaken through examining the data of companies in the Bovespa Index (IBrX- Brazil Index) during the May to August 2007 period, and its union with Multivariate Analysis.

The main goal of this article is to disseminate the statistical techniques used to join the exploration of the stock market, considering activity areas, business volume, and stock prices. It is divided into topics: first, is an explanation of the importance of studying the stock market and the Bovespa index; second, is a more detailed description of the adopted statistical techniques; topic three discusses the research methodology; fourth, we present the steps and application of the analyses in the software; and finally, the conclusions and results related to the research.

2. THE STOCK MARKET AND THE BOVESPA INDEX

The observation of reality is a product of the meeting of complex and uncertain events happening over time. Although these events are not equal, they are not totally opposed either. The stock market is, by nature, complex and uncertain and, therefore, an object of study made up of intricate value relations and forecasting models. It is a segment of the capital market which works with variable income bonds, and aims to channel resources to companies through risk capital. It allows for economic development and offers a means to assess future growth rates in capital, productivity and per capita income. It is a tool to help decrease the cost of capital, providing adequate financial conditions for company investments and directing stable resources to productive projects, accelerating economic and social growth.

In order to maintain their investment projects without subjecting themselves to credit markets, companies go public by issuing stocks for trade in organized markets (Stock Exchanges). Stock prices are established on the trading floor through the dynamics of each stock's forces of supply and demand.

A stock is a bond of variable income issued by a publicly traded company, which represents the smallest part of the issuing company`s capital. Stock owners are not company creditors, but company owners who are entitled to participate in the distribution of dividends, according to the proportion of the stocks they own. Stocks are called variable income assets because they are traded every day on the Stock Exchanges. Their prices can vary at any time as a result of

the investors' risk perception –based on historical price behavior– as well as future perspectives on the issuing company and its dividend policy. In short, investors are based on the market conditions and influenced by the Brazilian and international macroeconomic scenario.

Therefore, the complex volatile relations in a stock market are an important area for research, as they include diverse elements that mix different study areas. The stock market implies the need for a technical analysis that aggregates these areas in the assessment of price movements, elaborating a means to forecast the activity cycle of individual and joint values. This reality leads to a discussion of pertinent topics centered on the correlations between some aspects that can influence to a certain extent –direct or indirectly– the prices stocks will display on the market.

Data collection starts from the IBrX – Brazil Index: a price index measuring the return of a theoretical portfolio with 100 stocks, selected among the most negotiated on Bovespa, in terms of number of trades and financial volume. These stocks are weighted in the index portfolio by their respective number of stocks available for market trade. The 100 stocks that will make up the Index were chosen from a list of stocks ranked in decreasing order of liquidity, according to their tradability index (measured in the last twelve months). To be included in the Brazil Index, companies need to figure among the 100 best classified stocks in terms of tradability and they need to have been traded during at least 70% of the trading sessions occurred during the twelve months before the constitution of the portfolio.

Based on the main activities, the Index companies were distributed in 21 activity areas (Chart 1):

Chart 1
Activity areas in the IBrX – Brazil Index.

Activity Areas	
Water, Sanitation and Gas	Media
Foods	Mining
Beverages	Programs and Services
Commerce	Chemistry
Construction and Engineering	Various Services
Electrical Energy	Iron and Steel
Fuel Exploration, Refinement and Distribution	Fixed Telephony
Diversified Holdings	Mobile Telephony
Financial Intermediaries	Transportation
Wood and Paper	Transportation Material
Machinery and Equipment	

As we can see in Chart 1, each company belongs to only one activity area. Besides the activity area, the number of trades in April and the Sector/Bovespa participation were also tested in order to verify the companies' interdependences with the stock prices.

As for the main test variable, the mean values in April/2007 were collected from the Bovespa website, and classified as high, medium and low through percentile distribution. These values, displayed on the site, were calculated by the means of all values obtained in

April/2007, thus indicating the mean stock price in this data collection month. Distribution values are shown in Chart 2.

Chart 2
Percentile distribution of mean stock prices in april/2007.

		Mean Value in April/2007
Percentiles	33	24.9721
	67	49.2653

The variable indicating the number of trades reflects how many times each organization's stocks were traded in April 2007. The presented values, obtained from information on the Bovespa website, are classified according to the percentile distribution as high, medium and low; these individualized values are shown in Chart 3.

Chart 3
Percentile distribution of business in april/2007.

		Business in April/2007
Percentiles	33	6539.51
	67	19754.27

The Sector/Bovespa participation variable addresses the relation between the sum of all trades between May/2006 and April/2007 in companies from a specific sector, and the total number of Bovespa trades between May/2006 and April/2007. These values were also obtained based on information from the Bovespa website and are classified according to the percentage distribution as high, medium and low. The distributed values are displayed in percentiles in Chart 4 whereby a Sector/BOVESPA Participation relation under 0.0091 (percentile 33) classifies as low, and a relation between 0.0091 and 0.0678 or over this last value (percentile 67) is classified as medium and high respectively.

Chart 4
Percentile distribution of sector/Bovespa participation.

		Sector/BOVESPA Participation
Percentiles	33	0.009100
	67	0.067826

3. METHOD

3.1. The research

As mentioned above, all classification data were obtained directly from the Bovespa website, as was information about trades, participation percentage and mean stock prices. To perform this multivariate study focusing on the stock market, Correspondence and Homogeneity tech-

niques will be used to demonstrate the dependence in the relation between stock prices and the respective variables.

3.2. Correspondence analysis (Anacor)

According to Whitlark and Smith (2001), Correspondence Analysis (Anacor) is a technique that reveals the associations between a set of nominal categorical variables on a perceptual map, thus allowing a visual investigation of any data pattern or structure. Batista, Escuder and Pereira (2004) state that Correspondence Analysis is a graphical representation technique for flat projection of the multidimensional relations of the χ^2 distances between the categories of the study variables. In this study, we used symmetrical projection, which allows for the simultaneous investigation of the relations between lines and columns in the contingency table; that is, the relations between all categories of both variables. Categories located near one another in the flat projection are more strongly related than categories separated by larger distances. Any category, represented as a point on the perceptual map, can be analyzed separately and characterized according to the proximity of the projections of all other categories on a straight line connecting its characteristic point to the origin of the axes of the projection surface. When categories from the same variable are located close to one another on the correspondence analysis map, this suggests that, independently of their semantic contents, they can be considered equal in terms of the distribution of masses from the total number of observations made.

This technique was initiated by the French analyst Jean-Paul Benzécri at the start of the 1960's and represents an application of multivariate analysis to the exhibition of lines and columns of a data matrix (mainly a two-dimensional contingency table) as points in a qualitative dimensional space (Greenacre, 1984). Many studies use applications of Correspondence Analysis, including Aliaga (1999), Batista *et al.* (2004), Benzécri (1992), Caroll, Green and Schaffer (1986), Fávero, Belfiore and Fouto (2006), Greenacre and Blasius (1994), Haberman (1973), Hoffman and Franke (1986) and Olariaga and Hernández (2000). However, as mentioned above, this technique is not widely applied in accountancy.

As Hair, Anderson, Tatham and Black (2005) describe, Correspondence Analysis is a multivariate technique that has become increasingly popular for dimensional reduction and perceptual mapping. A perceptual map is considered to be the visual representation of an individual's perception of objects in two or more dimensions and, normally, this map contains opposed levels of dimensions at the extreme ends of axes x and y. According to these authors, Anacor is a recently developed technique, which analyzes non-linear relations and data with categorical responses measured in nominal terms. Its main objective is grouping highly associated variables, leading to the reduction of the number of predictive variables in the model and the representation of the relations between the variable categories on a perceptual map.

The advantage of this technique is that it provides a means to examine the relations, not only between the variables in rows or in columns individually, but also between the variables in rows and in columns jointly. This implies that when using this technique in the context of this study, the associations between the respondents' profile and their payment, credit and funding forms for the purchase of durable goods can be compared.

The method consists of two basic steps: the calculation of the association measure, and to the creation of the perceptual map. Anacor uses the χ^2 test to standardize the frequency values and establish the foundation for associations. Based on a contingency table, the expected frequencies and the value of χ^2 are calculated for each cell, considering the differences between observed and expected frequencies. Thus, using the standardized association measures, Anacor creates a measure in metrical distance and orthogonal projections on which the categories can be allocated, so as to represent the degree of association given by the χ^2 distances in a dimensional space.

Pestana and Gageiro (2005) recommend the χ^2 test, initially, to verify the existence of dependence between the two variables and, subsequently, to assess the adequacy of applying Anacor.

The same authors indicate a basic script for running Anacor. First, one can assess whether it can be considered for the model through the eigenvalue and the partial and accumulated inertias of each dimension. The square of each eigenvalue is called inertia, and it measures the importance of each dimension. The quotient between the inertia of each dimension and the total inertia gives the proportion of variance explained by the dimension.

The maximum number of dimensions (axes in the graphs) that can be estimated is one less than the smallest number between the number of rows or columns. For example, in a contingency table with three columns and five lines, the maximum number of dimensions will be two [min (row, column) -1]. After determining the dimensionality, the results can be examined in a graphical representation, called a perceptual map.

This graph is analyzed by examining the geometrical proximity relations and by projections in dimensions that can be identified from points on the surface and, thus, the categories that most explain the dimensions are those that present greater inertia per dimension and, at the same time, are located furthest from the origin (0,0).

For the sake of good results interpretation, according to Batista *et al.* (2004), one should bear in mind that the analysis level of this technique is essentially descriptive and cannot bear cause-and-effect inferences. The χ^2 test and residual analysis estimate the distancing between the performed and expected observation by simple randomness. Correspondence Analysis offers contrast information between relations of contingency variable categories, so that a stronger relation between two categories in comparison with other relations does not presuppose effects of one on the other.

3.3. Homogeneity analysis (Homals)

According to Figueira (2003), Homogeneity Analysis is about categorical data and refers to procedures known as Optimal Scaling, which allow the association of qualitative variables in functions of their levels and degree of complexity. In this sense, three types of Optimal Scaling procedure are appointed (Homals, Princals and Overals), and considered extensions of classical statistical techniques, such as main component and regression analysis. These techniques make it possible to accommodate qualitative variables and to reveal possible associations between them, in two dimensions.

According to the same author, although all of these procedures share Homogeneity Analysis of data, based on the premise of dimension reduction (multivariate analysis), the Homals procedure allows for the analysis of the correspondences of more than two variables with different numbers of levels. Therefore, Homals or Homogeneity Analysis allows us to study the relation between nominal variables and represent them in two dimensions (Pestana & Gageiro, 2005). Through this technique, the relations between all variables can be analyzed, jointly and simultaneously, based on a simple two-dimensional configuration. Thus, it can be used in social sciences and especially accounting, as many study and research variables are qualitative.

Therefore, Homals can be used to describe qualitative data, as it is particularly well adapted to treat research data in which the questions may have multiple answers. Formally, it is a simple application of correspondence analysis to a table with multiple levels. This method has certain properties that connect it to other statistical methods that grant it a particular character and make it the main component analysis of qualitative variables (Morineau, Lebart & Piron, 1995; Pires & Marchetti, 1997; Saporta, 1990; Weller & Romney, 1990).

Many authors provided significant contributions to the applications of Homals, especially Carvalho (2004), De Leeuw and Van Rijckevorsel (1980), Meulman (1982) and Pires and Marchetti (1997). The algorithm used in Homals represents a modernized version of the study by Guttman (1941).

Although the number of dimensions can be less than d_{max} for $m = 2$, Homals allows more than two dimensions. In this case, for the sake of better visualization of the association between the variables, a solution with two dimensions was chosen.

The observed data were organized in an $X\{x_{ijt}\}$ matrix, in which x_{ijr} represents –according to Iezzi (2005)– the value of each qualitative indicator observed in each of the 100 companies. The organization of each qualitative variable's levels is shown in Chart 5 below, according to what was described respectively in Charts 2, 3 and 4:

Chart 5
Variables and respective categorical levels.

Mean Value in April/2007 (Characteristic)	Low
	Medium
	High
Business in April/2007	Low
	Medium
	High
Sector/Bovespa Participation	Low
	Medium
	High

The activity areas associated with each category of the variables shown in Chart 5 were already presented in Chart 1.

According to Iezzi (2005), the application of different simple correspondence analyses (Anacor) allows for separating the variables currently associated (two by two) for future inclusion in a Homogeneity Analysis (Homals) for a set of simultaneous variables. In this study, the χ^2 tests presented significance levels of 0.003 (activity level and mean stock price variables), 0.069 (trades and mean stock price variables) and 0.186 (Sector/Bovespa participation and mean stock price variables), which denotes the existence of dependence relations between the study variables, at a level of 20%, making it possible to use Anacor and Homals.

As main disadvantages of the use of these techniques (Anacor and Homals), Greenacre (1984), Greenacre and Blasius (1994), Hair *et al.* (2005), Pestana and Gageiro (2005) and Tenenhaus and Young (1985), mention the restriction of the use of quantitative variables, the inexistence of variance evaluation among categories of variables and, as consequence, the impossibility to create a forecasting model. As this paper focuses on the exploratory perceptual study of the relationship among qualitative categories of the used variables for a period that has already occurred (May-August 2007), and not the elaboration of forecasting models that take into account quantitative attributes, such disadvantages lose importance in the application undertaken.

4. RESULTS

The Correspondence Analyses derived two dimensions for the flat projection of the variable categories. The adopted method was symmetrical normalization, which allows us to visualize the relation between rows and columns simultaneously.

Considering that the application of the techniques through specific software renders learning more practical and didactical, as the calculations are often obscured by an apparently accessible production of outputs, this study will use calculation procedures of the statistical software SPSS version 15.0. To begin with, we present the contingency tables for each of the study variables.

Table 1
Contingency table for mean stock price and activity area.

Activity Area	Mean Stock Price			Total
	Low	Medium	High	
Water, Sanitation and Gas	0	1	2	3
Foods	1	2	0	3
Beverages	0	0	2	2
Commerce	1	3	4	8
Construction and Engineering	3	2	0	5
Electrical Energy	2	9	4	15
Fuel Exploration, Refinement and Distribution	0	2	1	3
Diversified Holdings	0	0	3	3

(*Continued...*)

Table 1
Contingency table for mean stock price and activity area.

Activity Area	Mean Stock Price			Total
	Low	Medium	High	
Wood and Paper	3	2	0	5
Machinery and Equipment	1	1	0	2
Transportation Material	4	0	0	4
Media	1	2	0	3
Mining	0	0	2	2
Programs and Services	1	0	1	2
Chemistry	2	0	0	2
Various Services	4	0	0	4
Iron and Steel	1	3	6	10
Fixed Telephony	2	2	3	7
Mobile Telephony	4	0	0	4
Transportation	1	2	2	5
Total	33	34	33	100
χ^2: 69.538		GL: 40	p: 0.003	

Table 2
Contingency table for business in april/2007 and mean stock price.

Business in April/2007	Mean Stock Price			Total
	Low	Medium	High	
Low	9	9	15	33
Medium	16	9	8	33
High	8	16	10	34
Total	33	34	33	100
χ^2: 8.685		GL: 4	p: 0.069	

Table 3
Contingency table for sector/Bovespa participation and mean stock price.

Sector/Bovespa Participation	Mean Stock Price			Total
	Low	Medium	High	
Low	6	15	12	33
Medium	13	10	8	31
High	14	9	13	36
Total	33	34	33	100
χ^2: 6.188		GL: 4	p: 0.186	

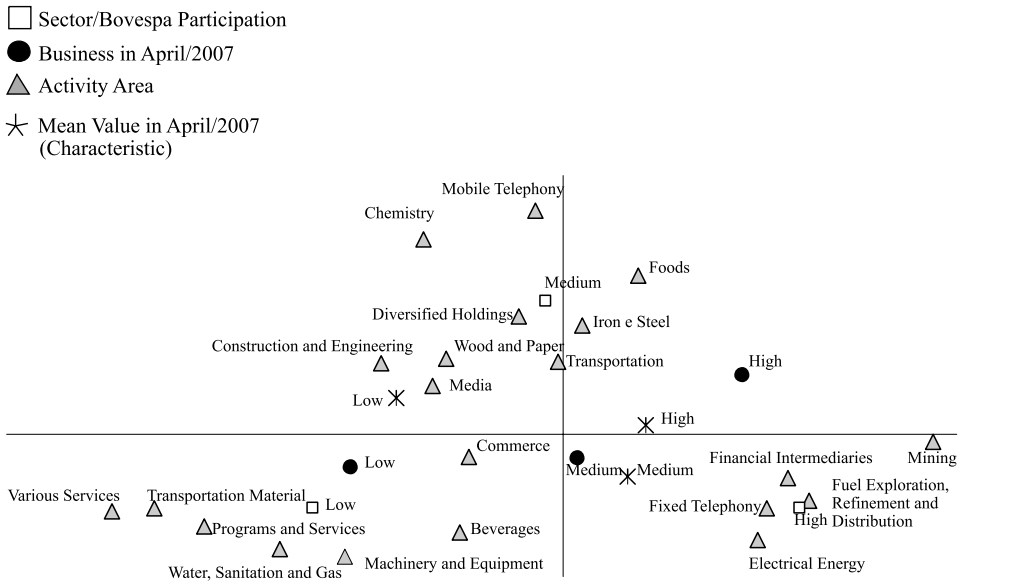
Based on these contingency tables and on the χ^2 tests, we can affirm that the Activity Area, Business in April/2007 and Sector/Bovespa Participation variables depend on the mean price of the stocks; thus, the relation is not random. These variables behave as possible causes for the obtained stock values.

After studying the contingency tables based on the analysis by the χ^2 test, we elaborated a two-dimensional perceptual map in the form of a graph showing the results. This serves to visualize the relative position of each level of the qualitative study variables. The more discriminatory the variables and the more distant the categories of the same variables, the more marked homogeneity will be as discrimination will be greater (Pestana & Gageiro, 2005).

Based on the Homals Analysis, which allows for identifying the interdependence between various indicators and categories on the perceptual map, presented in Figure 1, we can verify that some variables are more aggregated. This demonstrates probable associations between the bases of this study.

Figure 1

Perceptual map between activity area, business in april. Abril/2007, Bovespa/sector participation and mean stock price.



The map favors a view of three distinct highlighted groups. As this research focuses on the variables that affect stock prices –directly or indirectly–, it is perceived that the prices are well distributed, which, in turn, contributes to the creation of the aforementioned groups.

As for stocks with a low value, they largely belong to companies in the following activity areas: Mobile Telephony; Chemistry; Diversified Holdings; Wood and Paper; Media; Construction and Engineering; Various Services; Transportation Material; Programs and Services; Water, Sanitation and Gas; and Machinery and Equipment. A low Sector/Bovespa participation and a low number of trades can be some of the aspects that contribute to low stock prices, as this characteristic is associated with these types of values to a greater extent.

The stock prices with medium characteristics are more strongly associated with a medium number of trades in April/2007. A high level of Sector/Bovespa participation is associated with this medium value. The same is true for companies in the following activity areas: Financial Intermediaries; Fuel Exploration, Refinement and Distribution; Fixed Telephony; Commerce; Financial Intermediaries; Beverages; Machinery and Equipment; Mining; and Electrical Energy.

The high characterization for the stock prices is aggregated with a high number of stock trades on Bovespa in April. Where Sector/Bovespa participation is concerned, this is not specifically associated with one particular characteristic, as high stock prices vary between medium and high Sector/Bovespa participation. As for activity area, the group of companies associated with high stock prices comes from the Food; Iron, Steel, and Transportation sectors.

The use of these techniques demonstrates an exploratory and visual analysis, which contributes to the establishment of different conclusions about the interdependence of variables, constituting a behavioral analysis of statistical associations.

5. CONCLUSIONS AND POSSIBLE EXTENSIONS

The stock market implies the need for a multivariate technical analysis that aggregates different variables in the assessment, to allow one to make better forecasts and decisions. An exploratory tool can help to illustrate the small component parts of an apparently uniform problem.

The main objective of this article is the analysis of the stock market, and the study of multivariate models for accountancy. These areas are not being fully explored in scientific research in this field, and are only complementary in the different types of areas under analysis. The study of Statistics may be a promising tool that appears to support accounting analyses with a view to allowing greater veracity in the exposed facts and for complementing more complex themes.

The study revealed which variables influence stock prices. Thus, the result is important for a company's internal control, in terms of investment decision-making, and for new and frequent users of risk applications.

It is expected that this analysis may become a parameter for future accounting research on the stock market to use multivariate analysis. The main objective is to deepen knowledge of the stock markets and of multivariate models, establishing terms for the statistical comparison between different variables and, finally, generating models to draw conclusions on price variations.

According to Pestana and Gageiro (2005), Simple Correspondence Analysis (Anacor) and Homogeneity Analysis (Homals) are procedures used in contingency tables; that is, frequency distribution charts resulting from the crossing of two or more qualitative variables. Anacor is applied when studying the relation between two nominal variables, whereas Homals is used to study the relation between two or more nominal variables, allowing for the analysis of the relation between cases and objects, or between variables and cases. These are exploratory and not confirmatory techniques, which aim to discover possible relations between variables in a multidimensional space.

We conclude that stock prices and the aspects that influence them offer a vast field of study. Specific considerations about industry and price levels can be included in future researches. Despite this analysis has managed to obtain a positive assessment of dependence between the study variables, the performed test can constitute the base for other types of statistical analysis, as a deeper study to evidence these homogeneous groups.

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