A DECISION MODEL IN INVESTMENT ACCORDING TO PRICE/EARNING RATIO*

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ABSTRACT

There are enough empirical studies that show that both "practical people" and investment analysts use the price/earning ratio as a variable to make their investment decisions. These studies analyze whether a security is overvaluated or undervaluated. At the same time, investment strategies have been studied according to whether the security has a high or low price/earning ratio. This paper tries to give an analytical explanation for why such appraisal (valuation) might happen through price/earning, as well as the subjacent variables in such a ratio. Decision models are developed based on the investors' behavior. An empirical study of models for stocks traded in the Santiago Stock Market, simulating the investors' behavior and contrasting it with the real results, is also made.

Key words: Investment analysts; price/earning ratio; profit magin; liquidity; debt; arbitrage; equilibrium model; empirical testing.

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1. INTRODUCTION

This research shows a formation model of portfolio having as central point of the analysis the price/earning ratio (P/E). The exposition is made by using the P/E in security analysis, financial analysis and theoretic researches related to their use. The theoretic analysis context is the fundamental analysis, and the model consists in taking advantage of the earning/price ratio and separating it in three variables: the profit margin, the liquidity and the debt of the enterprise. From this separation, the model allows to associate the risks of each element and to analyze its influence in P/E. Traditional financial analysis concepts, some methodological approaches of financial theory and optimization techniques were used in the development of the proposal.

A model for enterprises that can determine the P/E from the expected variations in the profit margin, liquidity and debt is proposed. In a second stage, based on some suppositions, an equilibrium model is proposed; this global model allows to determine the price/earning ratio for each enterprise, considering the way each market enterprise acts and the way enterprises act together in the market. Each market enterprise behavior should be expressed in margin variation, liquidity and debt. An equilibrium in the price/earning ratio caused by a price adjustment is used to determine the overvaluation or the undervaluation of an enterprise.

An empirical verification of the global model and the enterprise model is proposed for a set of enterprises dealing their stocks in the Santiago Stock Exchange Market.

2. THEORETIC BACKGROUND OF THE PRICE/EARNING RATIO

The price/earning ratio is widely used by fundamentalist analysts and “practical people” when an investment decision is made. However, it has also been the cause of large theoretical and empirical studies. Wittbeck-Kisor (1963) tested a price/earning model which was one of the first in formalizing the study in function of dividend payout rate and standard deviation in the growth ratio of earning. This can be used to obtain the theoretical P/E ratio for any stock.

In the 60’s and early 70’s, different alternatives from the Wittbeck-Kisor’s model were studied. many of these models have really explained the price of a common stock in a specific period of time, but they are less successful in selecting the appropriate stock to buy or sell. On the other hand, these models are rather empiric (summarized in Elton and Gruber, 1991, chapter 16[1)]).

Further studies continue using price/earning ratio as an explanatory variable for different aspects of the stock exchange market. Thus, Peavy & Goodman (1983) showed that stocks with a low price/earning ratio give, on average, a higher return than those with a high P/E ratio, for stocks with the same CAPM beta models, expressing that returns, on average, might be obtained by investing in stocks with a low P/E ratio.

Friend (1977) and Blumer & Friend (1978) showed that investors make up their investment decisions in common stocks based on accountant data, from which P/E ratio is one of them. Barlev, Denny and Levy (1988) compared portfolios results based on accountant data with portfolios built in market data base using the statistics dominance rule of second degree, showing that the portfolios returns with accountant data have higher returns and lower variance. These data include the price/earning ratio as an accountant and market data combination.

De Bondt & Thaler (1985, 1987) explained why portfolios based on high or low price/earning ratio are formed. This is due to an overreaction adjustment made by investors on positive and negative overnormal returns which characterize inefficient markets. Howe (1986) and Brown & Harlow (1988) are

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1) Some models are Bower & Bower (1969), Gordon (1962), Gruber (1971), and Malkiel & Cragg (1970).

in accordance with the earlier ideas. On the other hand, Brown, Harlow & Tinic (1988) justified the price/earning ratio changes based on what they call “Uncertain Information Hypothesis”.

Other studies (Goodman & Peavy, 1989; Levy & Lerman, 1988; Dowen & Bauman, 1986; Jahnke, Klaffke & Oppenheimer, 1987) explained the investors’ performance effects following strategies based on low or high P/E ratio. The results are not convincing in only one direction. Chan, Hamao & Lakonishok (1991) showed the price/earning ratio effect using Japanese examples of portfolios with low or high price/earning ratios.

French & Poterba (1991) used the price/earning ratio as a central variable to explain the differences between Japanese and American enterprise stock prices, concluding that the accounting differences between both countries explain about half of the differences between their P/E ratio.

Reichenstein & Rich (1993) reported that the rational market position is that the dividend return and the price/earning ratio tend to move with the risk price to a non-observed market, and when the risk price is big, then the future average stock returns should be big and vice versa.

Fuller, Huberts & Levinson (1993) related that high P/E stocks have given historically positive alphas, and low P/E stocks have generated negative alphas. They tried to explain this phenomenon by analyzing three variables: earning growth rate subsequent to forming P/E portfolio, analysts’ forecast errors, and possibly omitted risk factors.

On the whole, in the cited papers, the P/E ratio is used as an important variable which alone or together with others helps to explain the portfolio price formation. On the other hand, a definition which places the P/E ratio in a higher or lower level in comparison to some alternative model is used. In general, the most important aspects of the P/E ratio are not discussed. Thus, it is interesting to focus the subject of the P/E ratio through a perspective which considers the global model market, where the intrinsic aspects of the P/E ratio are included by means of an equilibrium model.

3. CONCEPTUAL ASPECTS OF THE PRICE/EARNING RATIO

<u>Economic point of view</u>

Moligliani & Miller (1961), in their classic article on enterprise valuation, developed the price/earning ratio concept. Simplifying suppositions, they stated the following model (French & Poterba, 1991):

$$P/E = [1 + T\,(g - kr)] / r$$

where:
T is the reference time for the next t years;
g is the earning growth rate;
k is the earning proportions invested in each period;
r is the investment return rate.

Considering that there is no growth in the earning and the investors are willing to pay P price for a stock, obtaining k_1 return and that the earnings E will be kept constant for a long period of time, then using the present value we have the following relation:

$$K_1 = 1/(P/E) \qquad (1)$$

From the equality (1) we can see that the price/earning ratio is an approximate measure of the return which the investors demand in an *ex-ante* situation, or it is the approximate return which they won *ex-pos*t. Therefore, P/E ratio is an indicator of common stock return and this point of view it is an implicit indicator of alternative return. On the other hand, using present techniques for a finite n period, the P/E ratio can be described as:

$$P/E = [(1 + k)^{n} - 1] / k (1 + k)^{n} \qquad (2)$$

The expression (2) implies that the P/E ratio is equal to the present value of a unitary earning for a period during n periods and a return rate k.

Financial management point of view

Because the enterprise earning is the result of a management process, it is evaluated periodically. One of the management basic indicators is:

$$R_t = E_t / P_t = 1 / (P/E)_t \qquad (3)$$

where:
R_t is the holder's stock return in t;
P_t is the market price of a common stock in a moment t;
E_t is the earning for stock after interests and taxes, in t.

Usually R_t is estimated from the accountant data in both earning and equity. If we consider the equity to a market price instead of the accountant value, then (3) is equal to expression (1). From the management point of view, the holder's stock return presents advantages because it can be separated in three important management variables: the profit margin, the enterprise liquidity and the debt ratio. Thus, it can be expressed:

$$R_p = f (m, r, e) \qquad (4)$$

where:
m = Sales profit margin.
r = Enterprise liquidity.
s = Debt ratio level.

The equality use (4) is based on an ancient analysis application called "Du Pont Equation", as Weston & Brigham (1993) described. Parada (1988) analyzed this ratio use, where the return is separated in" economic effect estimated by the profit margin; liquidity effect estimated by assets turnover and, debt effect estimated by debt ratio. Earlier studies of this model are fully described in Parada (1990) and Parada & Contzen (1986).

In (4), it has been expressed that the return depends functionally on the profit margin, which is a variable of the product sale prices and the cost mix in both production and distribution factors. Given these last variables it is quite likely that the profit margin is a random variable (Parada, 1988 and 1989).

Moreover, we observe that the enterprise liquidity has an influence on the holders' stock return. As liquidity proxy, some turnover indicator of the operational assets can be used. Thus, it is likely to be some randomness degree. On the other hand, the holder's stock return is also affected by the debt level, which can be expressed through some debt/equity type indicator.

Expression (4) also carries implicit aspects which belong to enterprising management. Moreover, this expression implicitly includes market variables of production factors, capital markets, and final products markets.

By marginally analyzing (4), we get:

$$dRp = (f_{dm})dm + (f_{dr})dr + (f_{de})de \qquad (5)$$

where:
dRp is the variation in the holder's stock return from t to t + 1;

dm, dr, and de are variations in margin, liquidity and debt, respectively;
f_{dm}, f_{dr} and f_{de} represent the partial derivative for dm, dr, and de, respectively.

Expression (5) represents the approximation of the variation on the holder's stock return under changes considered in an isolated way on the profit margin, the enterprise liquidity, and the enterprise level of debt[2)]. The values of f_{dm}, f_{dr} and f_{de} represent the coefficients of sensitivity of the variables of margin, liquidity, and debt. This is an analogy with the concepts used in microeconomics for elasticity (Parada, 1987).

4. PROPOSAL OF THE P/E RATIO AS A DECISION MODEL

In the theoretical proposals about P/E, the performance of the common stocks in the market analyzed in terms of undervaluations and overvaluations depending on whether the P/E ratio is low or high (Levy & Lerman, 1985; Jahnke, Klaffke and Oppenheimer, 1987). Generally speaking, there is not any model of equilibrium based primarily on the P/E ratio, in order to indicate if it is high or low. Thus, this article will deal with the way of formulating a model which must be the result of a process of arbitrage in which the outstanding variable would be P/E, and, in turn, this variable must allow to decide when undervaluations and overvaluations exist.

Individual model for each enterprise

If the P/E ratio is used according to the mentioned bibliography, then, in turn, its components are evaluated at the moment they are to be analyzed. As it was mentioned before, the P/E ratio is a measure of the holder's stock return as described in equality (3). If we analyze the problem from that point of view and if we take equality (4) based on "Du Pont equation" application, we can expect that the P/E ratio can be, in turn, expressed in function of these three variables: the profit margin, the debt, and the assets turnover, all of them considered as outstanding variables; thus, the hypothesis that includes the idea that investors estimate these variables in an implicit way (Parada & Contzen, 1986).

The basis of this proposal lies on the fact that managers used these indicators in enterprises and, if this is true, obviously these variables are also relevant for the holders' stock, because, if it was not so, the managers would not use these ratios.

Expression (5) shows that the variation on the holders' stock return within a specific period from t to t+1 can be split into three factors. On the other hand, expression (3) demonstrates that the holders' stock return is a function of P/E in t. Therefore, we can expect for each stock:

$$dR = \beta_0 + \beta_1 dm' + \beta_2 dr' + \beta_3 de' \qquad (6)$$

where β coefficients represent each enterprise's marginal productivities of margin, liquidity and debt. More details of these proposals are analyzed by Parada (1987). Due to the implicit randomness in the variables, we can write the following:

$$dm' = dm + \varepsilon_1$$
$$dr' = dr + \varepsilon_2$$
$$de' = de + \varepsilon_3$$

where ε_1, ε_2, and ε_3 represent residual errors respectively in the variation or margin, liquidity, and debt. On the other hand, we have:

$$dm = (m_t - m_{t-1}) / m_{t-1}; \quad dr = (r_t - r_{t-1}) / r_{t-1}$$

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2) In differential calculus, expression (5) is valid if dm, dr and de are small.

$$de = (e_t - e_{t-1}) / e_{t-1}; \quad dR = (R_t - R_{t-1}) / R_{t-1}$$

where:
m is the profit margin;
r represents the enterprise's liquidity;
e represents the level of debt measured within the period t and t-1;
R is the holder's stock return.

If we suppose that the investors value an enterprise's return of an *i* stock through (6), then the variation on the holders' stock return and, hence, in the P/E ratio can be defined as a process with the following characteristics:

$$dR = \phi + \varepsilon \tag{7}$$

where $E(\varepsilon_1) = E(\varepsilon_2) = E(\varepsilon_3)$, and E represents the mathematical expectation.

The statistics errors have constant variance without serial correlation. Moreover, the correlation between ε and the variables dm, dr, and de do not exist. On the other hand, we have:

$$\phi = \beta_0 + \beta_1 dr' + \beta_3 de' \tag{8}$$

If we suppose that the investors value the return through this model, we assume implicitly that there exists a behavior based on these three variables. This situation is not surprising because the ratio which is being analyzed is widely used in both investment and financial-economics analysis, and in turn we consider implicitly that the investors regard this ratio as an element of decision as it was derived from the bibliographical data already analyzed. Scherk (1992) made an interesting exposition of the use of this ratio in investment analysis; Calzada (1992) developed what he called "the method of analysis of stock price" where the P/E ratio for PER, as he called it) is the outstanding variable in the process involving the determination of the price of a stock.

In expressions (7) and (8) we notice that there are two types of factors which exert influence on the generation of the return:

a) ϕ, represented by the features of management of each enterprise and expressed in the variables of margin, enterprise liquidity, and debt level;

b) ε, which represent other factors not included in an implicit way in the variables of management, such as the stock popularity in the market, the size of the company, the market participation, and features of the managers' team.

If we define $dR = (R_{p,t+1} - R_{p,t}) / R_{p,t}$ and $R_{p,t+1} = E_{p,t+1} / P_{p,t+1}$ and make adjustment on (6) we have:

$$(P/E)_{p,t+1} = [(P/E)_{p,t} / (1 + \beta_1 dm' + \beta_2 dr' + \beta_3 de')] \tag{9}$$

In model (9), the way how the P/E ratio can be determined for a p stock or enterprise from the expectations of the profit margin, liquidity, and debt is explained. We mathematically know that:[3]

$$\beta_1 = \sigma_R a_1 (dm - \overline{dm}) / \sigma_m$$

$$\beta_2 = \sigma_R a_2 (dr - \overline{dr}) / \sigma_r$$

[3] The demonstration appears in: "Statistic: Theory and Problem" by Murray Spiegel; McGraw-Hill, Chap. XV, 1961, USA.

$$\beta_3 = \sigma_R a_3(de - \overline{de})/\sigma_e$$

where:
dm, dr, and de are averages respectively of variation in margin, liquidity and debt;
σ_m, σ_r, and σ_e are standard deviations respectively in margin, liquidity, and debt;
σ_R is the standard deviation for the holder's stock return.
Coefficients a_1, a_2 and a_3 are derived from the following system of matrix equations:

$$z_{a1} = r_{R1}$$

where:

Z is the coefficient matrix of the correlation between margin, liquidity and debt;
a_1 is the vector of a_1 unknown coefficients;
r_{R1} is the vector of coefficients of correlation within the variations of the holder's stock return and the i variables, which are variations on margin, liquidity and debt.

Concluding, in the β coefficients the implicit risk on margin, liquidity, and debt are measured, having as a risk unit the relation $(d_i - \overline{d_i})/\sigma_\iota$. if the standard deviation of margin, liquidity, and debt measures the risk of the variables, therefore, β takes up the difference between an expected variation and its average on each risk unit. In turn, the coefficient on each risk unit of the holder's stock return is pondered by the cross-relation with the three variables. The explanation of this method is analyzed in Parada & Contzen (1986) and Parada (1987).

it is evident that model (9) allows to determine the value that the (P/E) ratio in t+1 should have on each enterprise, taking up the implicit risk on the holder's stock return, liquidity, and debt, as well as the cross-relation within the variables and the P/E ratio on t. Thus, this is a model that allows to estimate the intrinsic value of the P/E ratio on each enterprise. To achieve this, the investors must know the enterprise's perspectives all the time, based on its profit margins, liquidity and debt level, besides the β coefficients.

Global model of market

In the individual model, the typical aspects of the capital market and the total interrelated behavior of the enterprises are not included. Thus, for n enterprises we have n P/E ratio and n forecasts in dm, dr, and de. If P/E has an outstanding role in making a decision, it can be expected that a global level exists which gathers all the available market information about these three variables. In this case, the market will be formed by n enterprises which will be represented by a global level where a dRp of each enterprise exists. The level which indicates the stocks equilibrium is:

$$dRp' = \lambda_0 + \lambda_1 dm + \lambda_2 dr + \lambda_3 de + \varepsilon p \qquad (10)$$

where:
λ_1 are sensitivity coefficients of the i variable (dm, dr, de);
dRp' is the holder's stock return on a global level;
εp are aleatory errors.

It is interesting to note that λ_0 can be interpreted as an equivalent return to an instrument free of risk. empirically, it must be zero because of the very definition of a riskless rate; thus this should not vary from t to t+1. The errors εp can take up all the aspects which are not included in dm, dr, and de. Factors such as the size of the company, industrial concentration degree, holder's share concentration, economic cycles and levels of technological change among others, can be included within the errors.

On the other hand, r coefficients take up the behavior of financial and economic variables. Thus in $\lambda 1$ aspects of the demand and the supply functions are expressed; $\lambda 2$ includes aspects of liquidity concerning all the market enterprises; and $\lambda 3$_takes up the debt and the interest rates of the financial market. Then, for the (P/E) ratio we have:

$$(P/E)^{m}_{p.t+1} = [(P/E)_{p,t}/(1 + \lambda_1 dm + \lambda_2 dr + \lambda_3 de)] \qquad (11)$$

Through models (10) and (11) undervaluations or overvaluations can be determined. These models will be corrected through a process of arbitrage on the price of security. With this interpretation and from the P/E ratio a level of equilibrium is derived.

Security price adjustment based on the P/E ratio

The question whether or not in the real world the investors choose different portfolios through the P/E ratio should not impose suppositions for explaining their performance. It is necessary, however, to set the conditions for studying analytically the way the price adjustment is produced. These conditions are:

a) Portfolios containing undervaluated or overvaluated stocks are to be created, considering the difference $(P/E)_{p,t+1}$ of each company in respect to the global model $(P/E)^{m}_{p,t+1}$;

b) the new portfolio will be financed by means of the actual stock-invested resources;

c) investors are risk-restricted maximizers; on the other hand, they have the same expectations related to dm, dr, and de variables;

d) there is a competitive stock market holding no input-output barriers; there are no transaction costs;

e) a minimum of α_1 should be invested in each stock; this value is to be defined by every investor;

f) there is the possibility to invest in riskless assets that generate a R_L return.

The arbitrage is justified by the economic interpretation given to the P/E ratio. In fact, the inverse of (P/E) indicates the approximate stocks return. If $(P/E)^{e}$ = price/earnings according to the individual model and $(P/E)^{e}$ = price/earnings according to the global model, then the following situations are possible:

a) $(P/E)^{e} > (P/E)^{m}$. In this case, the return according to the individual model is inferior to the return according to the global model. This will cause a decrease in the demand of a stock because its return is smaller than the normal considering the global level which involves the economic behavior of all the enterprises in general. So, a decrease in the demand will produce a diminishing in the stock price, and the P/E ratio will decrease. This situation will continue until the P/E ratio reaches a point over $(P/E)^{m}$, which shows the return of the global model. Thus, this is the case of a stock undervalued regarding the global model.

b) $(P/E)^{e} < (P/E)^{m}$. In this case, according to individual forecasts, the stock return -based on the inverse of the P/E ratio- is greater than it should be regarding the global model. If this is so, then the demand for this stock will be increased because it will become far more rentable than the rest of the stocks in the market and far more attractive. This will produce a rise in the price of the stock and will cause the P/E to increase until it is over the global level. so, this is the case of a stock overvalued regarding the global model.

As an arbitrage is due in (a) and (b), an equilibrium point is to be reached in the global level where $(P/E)^e = (P/E)^m$.

Portfolio formation

The investors will form portfolios with those stocks which are not equilibrated, because, in that way, they can get abnormal earnings thanks to the overvaluations and undervaluations. Once the equilibrium is reached, they will form portfolios only with stocks which are over the global level. In order to increase their wealth, they will invent x_j in each stock. Their objective is:

$$\text{MAX: } \sum_{j=1}^{n} | x_j (P/E)^m_{j,t+1} - x_j (P/E)^e_{j,t+1} | \qquad (12)$$

where:
x_j is the proportion invested in a j stock (per one);
$(P/E)^m_{j,t+1}$ is the forecast of the P/E ratio of a j stock, in t+1, according to the model presented by every enterprise, and calculated through (9).

Expression (12) indicates that non-equilibrated x_j stocks will be taken. If

$$(P/E)^m_{j,t+1} = (P/E)^e_{j,t+1}$$

then the securities are located in the same level. The absolute value is taken so as to discriminate between overvalued and undervalued stocks, leaving them in the same condition. If adjustments in the price are to be considered, both stocks have the same importance, because it only interests -according to (10)- how far they are from the global level.

To make possible the existence of portfolios there must be a premium for taking the risk of forming overvalued or undervalued portfolios. This premium comes from the existence of riskless assets. So, the investors expect that the return of the selected portfolio will be superior to the return of the investment in riskless security. If this restriction is not fulfilled, the investors will not take the risk of buying stocks. In that case, it is convenient to create portfolios with equilibrated assets. This restriction can be mathematically explained as follows:

$$\sum_{j=1}^{n} R_j (B_{ij} d_{ij} + 1) x_1 \geq R_L \qquad (13)$$

where:

$$B_{ij} = [\beta_0 j, \beta_1 j, \beta_2 j, \beta_3 j] \; V_j \quad j = 1, ..., n$$

B_{ij} is the sensitivity coefficient vector belonging to the i variable (variations in variables dm, dr, and de) for a j enterprise. β_{0j} is a position coefficient statistically expected to be equal to zero. This will be explained in the following section of this article;

$$d_{ij} = [1, d_{mj}, d_{rj}, d_{ej})^T$$

d_{ij} is the transposed vector of expected variations in the i variables of a j enterprise;
The i subindex represents the variation variables of margin, liquidity, and debt;
R_L is a riskless rate;
$R_j = (P/E)^{-1}$ in a t moment.

The left side of (13) represents the expected return for the portfolio in t+1.

On the other hand, we know that a portfolio requires diversification, as a way to reduce the risk. The greater the number of stocks in the portfolio, the greater the diversification and the lesser the risk. In this case, we have to consider that diversifying means to “put the eggs in separate baskets”, thus divide the investment in different stocks, which is possible with the following restriction:

$$x_j \geq \alpha_j \qquad (14)$$

Where α_1 is the minimal proportion of the total of resources which every investor wishes to invest in a j stock, according to his preferences. This is, after all, an imposed condition with the main aim of avoiding that the investors concentrate their portfolios in stocks which are far away from the equilibrium point. All this because investors are maximizers and, as they could make use of linear programming, they could even have a portfolio holding only a single stock. This restriction makes possible to include investable stocks according to the investor’s preferences. It also allows to keep a certain subjection to the original portfolio, which was previous to the creation of the optimal portfolio. This restriction conditions the objective function of maximization, which obviously has a cost due to the minor concentration of non-equilibrated securities that could generate a major return.

Another restriction to the problem of selection of a portfolio is given by the available resources. This makes us consider that $\Sigma x_j = 1$. which means that all the resources are invested in the portfolio.

From the linear programming solution x^*_j will be obtained, which indicates the proportion of the total of resources to be invested in a j stock, considering a maximizing behavior. If we assume that an investor has an actual portfolio with an inversion equals to x'_j for every j stock, then the following situations are possible:

a) $x'_j > x^*_j$
b) $x'_j < x^*_j$
c) $x'_j = x^*_j$

In (a) j must be sold in the actual portfolio in order to get resources to buy new securities which will have a more intensive participation in the new portfolio. In (b), j securities must be bought in order to increase the level of participation in comparison with the original portfolio. In (c), it is not necessary to do anything because the proportion remains the same.

As it can be seen, the portfolio of maximization implies the use of linear programming to determine the optimum values of x_j. The use of linear programming is not arbitrary and depends on the linear characteristics of the problem and on the empirical fundament of its use in the case of the selection of a portfolio, as it is stated by Sharpe (1967). Levary & Avery (1983), and Ronn (1987).

It is interesting to analyze whether there is an arbitrage portfolio or just a number of stocks reorganized within the actual portfolio, since the characteristics of the portfolio are not mentioned.

There are, however, certain conditions to turn the new portfolio into an arbitrage-to-be portfolio. According to Jarrow (1988), these conditions deal with the price of the portfolio as a whole which must be different from the price of the stocks combined in a separate way. Thus,

$$p(\sum_{j=1}^{n}(x_j RT)\sum_{i=1}^{n} x_j RT_p(x_j) \qquad (15)$$

where:
p is the price of the portfolio as a whole;
p(xj) is the price of a j stock bought separately;
RT are the total resources;
xj is the proportion of investment in j stocks.

According to this restriction it will be possible to equate the optimized portfolio with the arbitrage-to-be portfolio.

Despite this fact, the maximizing portfolio selected can become an arbitrage portfolio when the imposed condition of producing positive cash flow is fulfilled. This is another condition which defines an arbitrage portfolio. In this case, due to the restriction which the portfolio has, a return rate is equal to the riskless rate from which a positive cash flow is expected.

5. THE GLOBAL AND THE INDIVIDUAL MODEL EMPIRICAL RESEARCH

Enterprises and period selected

The theoretical proposals stated before have been tested by Chilean companies which usually have transactions in the Santiago Stock Market.

This study includes enterprises with public information for a long period of time and with thick trading. A third criterion used to select enterprises demanded that they were private. Government-owned enterprises were not considered despite that they had a thick trading, because during the 80's less than 1% of their corporate stocks were transacted mainly because only very few shares were in private hands.

According to these criteria, 20 enterprises out of 232 were included in this study. The total trade of stocks selected represented in 1992 nearly 10% of the total trade in the Santiago Stock Market. Due to restrictions on the number of periods of public, regular, and uninterrupted information, this research analyzes data gathered from the first trimester of 1980 to the second trimester of 1993.

Global and individual models

In order to define the return of the holders' stock (R_p) the earnings were considered after interests and taxes, and divided by the common stock valued to the market price. The margin (m) was defined by the earnings after interests and taxes divided by total sales revenue; the assets turnover index (r) was used as proxy of the liquidity; and the debt was calculated by means of the debt/equity ratio (e). This calculation process was applied to all the 20 companies and the data were gathered every trimester from all available information published by *Analisis y Antecedentes Financieros de la Bolsa de Comercio de Santiago*.[4]

The first individual model for every company was obtained from the following equation:

$$dRp = \beta_0 + (dm)\beta_1 + (dr)\beta_2 + (de)\beta_3 \qquad (16)$$

where:

$$dm = (m_t - m_{t-1} / |m_{t-1}|$$

$$dr = (r_t - r_{t-1}) / |r_{t-1}|$$

[4] In order to calculate the earnings and the incomes, one year data ending in the corresponding trimester were used.

$de = (e_t – e_{t-1}) / |e_{t-1}|$

$dRp = (Rp_t – Rp_{t-1})/|Rp_{t-1}|$

OLS was used to calculate the betas (16) of every company. The software Time Series Processor (TSP) was used. The hypotheses to verify are $\beta_0 = 0$ and β_1, β_2, β_3 - 0. It was necessary to calculate betas for the last six periods, thus successively from January 1980 to December 1991 and from January 1980 to March 1993. The result of the last period regression is shown in table 1. The rest of the betas are fully displayed in table 2.

TABLE 1
$R_P = \beta_0 + \beta_1 dm + \beta_2 dr + \beta_3 de$ MODEL(1)
(Jan. 1980 - Mar. 1993 trimestral data)

COMPANY	β_1	$T(\beta_1)$	β_2	$T(\beta_2)$	β_3	$T(\beta_3)$	R^2	F	DW
Andina(2)	2.1	10.6	-2.93	-2.8	-0.47	-0.57	0.89	111.3	1.84
Cartones	0.85	59	2.11	1.9	0.98	2.6	0.99	1906	2.03
Cementos(3)	0.90	77.3	2.2	29.9	1.15	10.9	0.99	3821	2.09
Concha y Toro(2)	0.99	208	1.28	3.4	1.03	6.8	0.99	1315	1.98
Copec	0.84	14	1.04	1.77	-0.12	-0.42	0.85	115	1.82
Cholguan	1.33	53	1.25	4.9	1.05	8.6	0.98	1620	2.3
Elecmetal	0.80	9.2	0.45	1.71	0.52	1.71	0.68	43	2.07
Fosforos	1.4	66	0.99	6.4	0.74	3.33	0.99	2168	1.58
Gas	0.64	3.14	0.003	0.001	-1.66	-8.1	0.79	78	2.22
Litoral	1.17	5	0.11	1.8	0.19	2.2	0.43	16	2
Luchetti	0.98	34	1.20	9.2	0.85	12	0.97	585	2.1
Madeco	0.83	54	1.05	4.04	0.72	5.5	0.98	1586	2.09
Madera	0.40	7	0.20	4.8	0.74	3	0.71	49	1.90
Melon	1.01	44.5	1.25	7.7	0.85	14	0.98	1345	2.31
Minera(2)	1.20	21.6	-0.004	-0.42	1.42	21.9	0.98	839	1.6
Polpaico(2)	0.98	131	-0.020	-0.060	0.58	6.6	0.99	5244	1.97
Tatersal	1.21	10.7	-1.4	-1.28	-1.45	-8.1	0.84	107	2.1
Vapores(2)	0.04	3.7	-0.08	-0.89	0.58	2.8	0.57	17	2.07
Vida	0.86	19	0.13	0.1	0.13	0.47	0.91	202	1.84
Volcan	0.82	19.7	0.89	29.2	0.96	26.6	0.98	1010	2.07

(1) Selfcorrelation was corrected with the Cochrane-Orcutt method.
(2) In the analysis, almost every company had a β_0 coefficient statistically equal to zero. For this reason, a regression was made in the origin for all the enterprises of the group.
(3) In response to the extreme values observed, data destined to the first 12-month regression were suppressed due to the evident distortion caused by this situation

As for the global model, the case of a portfolio with the same weight for every one of the 20 companies was analyzed. This is equivalent to getting the simple mean of every one of the variables studied, and it was calculated considering the mean of <u>Rp</u>, <u>dm</u>, <u>dr</u> and <u>de</u> of every period and every trimester; then the data were regressed. The results of this regression are shown below, in the global model of the stockholder's return[5] (1980-1933 trimestral data).

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[5] In this model, as in the individual case, β_0 is equal to zero, statistically speaking. For this reason, a regression was made in the origin, the numbers enclosed in parentheses under the model are the t-statistics

$$dRp = 0.83dm + 0.37dr + 0.868de$$
$$(11.3) \quad (1.97) \quad (5.5)$$

R^2 adjusted = 0.77 DW = 1.83

F = 64.9

The following observations are generated in response to the results obtained from the individual models applied to every one of the companies.

a) The model applied to each enterprise shows a high correlation coefficient, and this coefficient is checked with a high F test. This indicates that the variables which have been considered are right, and, consequently, the model is well specified. To an individual level, the profit margin level and the debt level are statistically significant. For five enterprises, the liquidity variable has no statistical significance.

b) In general, the betas or coefficients of sensitivity are stable during the six periods analyzed and for the three variables. On the other hand, the β_0 coefficient is statistically non-significant for most of the companies. This agrees with the first part of the article in that β_0 is a riskless rate and is also zero because the model analyzed is part of a marginal analysis.

c) Another observation is that the values of the coefficients β_1, β_2, and β_3, either positive or negative, are not so far from the unit.

d) We can see that the global model is well specified statistically speaking and that the three variables considered in a global and in an individual model are statistically significant. On the other hand, the coefficients of sensibility are moderate, and all of them are below one. The error variance reaches 23% of the total variance, which is interpreted -as it was said in theory- as other factors that influence the stock return determination.

e) As we analyze the six last periods of the global model, we can notice stability in the coefficients of sensitivity.

Analysis of the overvaluated and undervaluated stocks according to the global and individual model

Methodology

In order to analyze the undervaluations and overvaluations of the stocks it was necessary to calculate the P/E ratio for every enterprise, according to the individual model expressed in (9) and to global model (11). This calculation involved the last six trimesters, and the methodology used was the following. In the beginning of every t semester we had a p/E ratio which also corresponds to the end ratio of the t-1 period. Then we assume that the variables dm, dr, and de really reached the values observed during the t period. This also means that all the investors had the same expectation. For the calculation at the end of t we used the initial betas for t. With all these data, models (9) and (11) were replaced. So, the $(P/E)_{t+1}$ ratio corresponding to the global model used until June 1993 is equal to $(P/E)_t$ /(1 + 0.83dm + 0.37dr + 0.868de). We can conclude that the inputs of the model are: $(P/E)_t$ which is a known datum; β_1, β_2, and β_3, which are also known: and dm, dr, and de, which are the expectation values for the t period. With all this, a stock is undervaluated when:

$$(P/E)^m_{t+1} < (P/E)^e_{t+1}$$

The supra index m implies the global model and the supra index e corresponds to every enterprise model. On the opposite case, the stock will be undervaluated according to the global model. Afterwards, we compared $(P/E)_{t+1}$, according to the global model, with $(P/E)_{t+1}$, in order to see how far are the results from the models. As we said before,

$$(P/E)^m_{t+1} - (P/E)^e_{t+1}$$

and

$$(P/E)^m_{t+1} = (P/E)_{t+1}$$

All the data provided in this methodology are shown in table 2.

Global results

The results of the forecasts are shown in table 3 and in the graphs 1 to 6. The tables show the P/E ratios projected according to the individual model of every enterprise, and moreover to the global model, and the actual P/E ratio. The real or effective P/E corresponding to the end of each period is also included; variations in margin (dm), liquidity (dr) and debt (de), as well as the betas of the variables, are presented in the same way. There are six tables containing data from January 1981 to March, June, September, and to December 1992; and March and June 1993, respectively.

The same projection of the P/E ratio for the twenty enterprises whose values were calculated according the enterprise and global models are in the graphs 1 to 6. They also contain the real P/E obtained in the period of analysis.

A portfolio containing the set of 20 stocks studied has been created by investing equal weights in every stock. These results are shown in table 2.

TABLE 2
P/E RATIO FOR THE 20 STOCKS PORTFOLIO

FORECAST	INITIAL P/E	FORECASTED P/E RATIO		REAL P/E
		INDIVIDUAL MODEL	GLOBAL MODEL	
Jan -Mar.1992	15.97	16.78	18.11	18.98
Apr - June 1992	18.98	18.37	17.41	17.55
Jul - Sept. 1992	17.55	16.84	15.1	14.81
Oct - Dec. 1992	14.81	14.74	14.26	14.38
Jan - Mar. 1993	14.38	15.41	15.21	15.55
Apr - June 1993	15.55	17.76	16.83	17.76

In table 2, if we compare the P/E ratio forcasted for every period according to the global model, we see that it should have raised by the end of the periods Jan-Mar. 1992, Jan-Mar. 1993, and Apr-June 1993. In fact, this P/E raised in comparison with the P/E observed in the beginning of the trimester. On the other hand, in periods April - June 1992, July-September 1992 and October-December 1992 P/E should have decreased according to forecasts made with the global model and, in fact, it decreased by the end of the period. this implies that the global model has had a behavior similar to actual or effective; on the other hand, we can see that P/Es according to the global model are equal to actual P/Es in all the trimesters, statistically speaking, and there are few differences between them.

A second conclusion based on table 2 is that there are differences between the P/E forecasted by enterprises and the P/E projected with the general model. These differences are the base to form optimized portfolios, just as we have mentioned in the theoretic part of the model.

Summarizing, we can observe that the results of the model are coherent if we contrast them with the actual measures, and that the global model makes good approximations to reality.

Results for enterprises

After analyzing table 3 and graphs 1 to 6 we can conclude the following:

a) The $(P/E)^m$ ratio according to the global model had a statistical behavior similar to the P/E observed at the end of every trimester during the six periods projected for almost all the enterprises. For instance, in the last trimester of 1992 there were 13 companies whose P/E, according to the global model, should have raised by the end of the trimester and, if we take a look at the lst column indicating the real P/E, we can see that this really happened. During the following periods of simulation, only two or three companies do not have such a similarity and we can notice that the number of rises and falls change, though they do not affect the same enterprises.

b) As we compare the $(P/E)^e$ ratio based on the individual model with the P/E based on the global model, we verify (see graphs) that the number of coincidences for every simulated trimester is more than seven enterprises. The rest of the enterprises which were used to create optimizing portfolios, as it was mentioned in the theoretic part of the article, show undervaluations and overvaluations. It is interesting to point out that coincidences between P/E and $(P/E)^m$, such as can be seen in the graphs, do not constitute a perfect equality but, statistically speaking, they are the same as having 1% of error.

c) As we compare $(P/E)^m$ with $(P/E)^e$ the number of coincidences for the enterprises analyzed is higher than the coincidences observed in (b). This corresponds to the observation made for the portfolio, and, at the same time, confirms statistically that the global model makes good approaches to reality considering each enterprise.

d) As we analyze the $(P/E)^m$ ratio simulated according to the global model for every enterprise and for the period of time forecasted, we can observe that the data obtained are relatively stable without heavy fluctuations. There are some breaks within the cases analyzed (Luchetti, Concha & Toro, and Litoral), who coincide with changes in the actual P/E. This can be explained by the fact that there are no registers of great changes in the variables <u>dm</u>, <u>dr</u>, and <u>de</u>, and that all this is product of the stability in the Chilean economy during the analyzed period. On the other hand, the β coefficients also show a moderate behavior which exerts influence in the stability of P/E ratios.

6. CONCLUSIONS

From the bibliography analyzed we reached the conclusion that there were enough antecedents to support the use of the P/E ratio as a relevant variable to explain the formation of the price of stocks. The theoretical background for this is based mainly on what is called fundamental analysis. However, the main problem with this analysis is that the P/E ratio projects its results for a specific period of time and it is not part of a global model, in which adjustment through prices comes to an equilibrium.

So, the basis of what could become an equilibrium model is set considering the P/E ratio as the central element of making a decision. From simple relationships a model is created based on variables widely spread in financial and economic analysis. The idea results coherent and some supposed simplifiers are made.

As an empirical verification is made in the first part of the model, that is the model corresponding to each enterprise and the global model, some important conclusions are obtained. The first one is that the model is well defined for each enterprise, indicating that the variables selected are proper to the problem given. This, in theory, was expected because the variables selected have a theoretical basis.

At an individual level, we can also observe that the P/E ratio forecasts formulated through the global model are very good representations of reality for the enterprises analyzed. On the other hand, after analyzing the P/E forecasts for enterprises in the individual model and comparing them with P/E ratio forecasts calculated according to a global model, some differences, though little, are detected. Based on these differences, optimized portfolios are formed, as explained on the theoretical part of this article.

Despite the outstanding results of the model, this empirical research must be enlarged to a higher number of enterprises and for a longer period, as well as to markets different from the Chilean ones.

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