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RELATIVE PERFORMANCE OF VALUATION USING MULTIPLES. EMPIRICAL EVIDENCE ON BUCHAREST STOCK EXCHANGE

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Abstract. This paper examines the valuation performances of seven multiples on a sample of BSE-listed firms. When industry membership is used as the selection method for comparable firms, the P/CF multiple leads to the best valuation performance. P/E, P/B, P/CF and P/TA multiples assure the highest accuracies when ROE is used as the selection method for comparable firms. In the case of both selection methods of comparables, the P/S multiple leads to the least accurate valuation. In this study, accuracy levels of multiple valuations are generally lower than those obtained using the same methods on more developed capital markets.

1. Introduction

This study examines the valuation performance of various multiples. Valuation using multiples is a relative valuation method that estimates equity/firm value by multiplying the target firm's value driver by the synthetic multiple of comparable firms. The synthetic multiple is obtained by averaging comparable firms' multiples. Multiples are computed as the ratio of the equity/firm value to the value driver.

Valuation using multiples requires some important choices that have to be made. The first ones refer to the value-relevant measures: market price value (the multiple's numerator) and value driver (the multiple's denominator).[1] These choices lead to the multiple on which valuation will be based. Another important choice regards the method of selecting the comparable firms. Although the industry membership rule is the standard approach in practice, the empirical research identified methods that yielded higher accuracies than that of the industry membership method many times. These methods are based on control factors for growth, risk and profitability. Finally, another important choice on valuation using multiples refers to the statistical measure for the aggregation of comparable firms' multiples. The harmonic mean and median are two of the most widely used estimators.

This paper studies empirically the valuation accuracy of seven multiples (P/E, P/B, P/CF, P/S, P/TA, EV/EBIT, and EV/EBITDA) when comparable firms are selected based on industry membership and ROE.[2] The sample of this study is based on BSE-listed non-financial firms. Thus, research on valuation using multiples is extended to an emerging capital market. The emerging capital markets represent the object of empirical research on valuation using

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[1] A common classification of multiples is based on their market price value. There are equity value multiples whose market price values are equity values (such as market price) and entity value multiples whose market price values are entity values (such as enterprise value).

[2] The appendix A at the end of the article contains a list of abbreviations. It also includes definitions of variables used to construct the multiples analysed in this study.

multiples to a smaller extent.[3] This study represents, according to my knowledge, the first empirical study on the relative performance of multiples focused on BSE firms. Its results are directly relevant to BSE investors.

The objectives of this study are the following:

1). To rank the valuation performances of different methods of valuation by multiples for BSE-listed non-financial firms.

2). To assess the absolute performance of valuation using multiples for BSE-listed non-financial firms.

The paper is organized as follows. The next section presents the related literature. Section 3 contains the research design of the study, Section 4 describes the sample, Section 5 presents the empirical results, and Section 6 concludes.

2. Related Literature

Theoretical literature on valuation using multiples has known an important progress over the past years. Lie and Lie (2002) noticed that surprisingly few studies had examined the accuracy of different valuation techniques. In a later study, Dittmann and Weiner (2005) observed that the empirical research on multiple valuation was focused on the accuracy of valuation techniques and on the statistical measure for averaging the multiples of comparable firms. They noticed that only little research had analysed the selection methods of comparable firms. However, more recent studies pointed out a better state of the empirical research on this topic. Cooper and Cordeiro (2008) remarked an "extensive academic interest" that has been gained "only recently" by equity valuation based on multiples. In addition, Fidanza (2008) considered "certainly very wide" the theoretical literature on this theme.

A great part of the empirical research on valuation using multiples dealt with the relative performance of multiples. Kim and Ritter (1999) examined the use of several multiples for valuing IPOs and found that the use of the P/E multiple based on forecasted earnings leads to a superior accuracy relative to those of multiples based on book value, trailing earnings, cash flows, and sales. Baker and Ruback (1999) analysed the performance of multiples based on EBITDA, EBIT, and sales. Their results indicate that industry-adjusted EBITDA performs better than EBIT and sales.

Liu, Nissim and Thomas (2002) studied the performance of a comprehensive list of value drivers and found the general rankings of multiples as follows: 1. forward earnings measures; 2. historical earnings measures; 3. cash flow measures and book value of equity; and 4. sales. Liu, Nissim and Thomas (2007) discovered for their sample a higher accuracy of earnings than those of operating cash flows and dividends. After the shift from reported numbers to forecasted ones, they obtained higher valuation performances for all multiples. They revealed that earnings still had the best performances in this case, because their accuracy increased more than those of the other two measures.

Lie and Lie (2002) arrived to the following conclusions regarding the relative performance of multiples: 1. the total enterprise value/book value multiple generally yields better value estimates than sales and earnings multiples (total enterprise value/EBIT and total enterprise value/EBITDA), especially for financial, but also for non-financial firms; 2. the use of forecasted earnings instead of trailing earnings improves the estimates of the P/E multiple; 3. the EBITDA multiple generally yields better estimates than the EBIT multiple, except for pharmaceutical companies.

[3]From the identified studies that focused on valuation by multiples, the great majority are dealing exclusively with U.S. data. A few studies focused on European data (Herrmann and Richter, 2003, Dittmann and Weiner, 2005, Schreiner, 2007) and used U.S. data to verify their results, a study has been made in an international context (Liu, Nissim and Thomas, 2007), a study is focused on firms listed on the Milan Stock Exchange (Fidanza, 2008) and another one on the Japanese equity market (Park and Lee, 2003).

Park and Lee (2003) analysed the valuation accuracy of P/E, P/B, P/S, and P/CF multiples for the Japanese stock market. Their results indicate that the best multiple in terms of prediction accuracy is the P/B multiple.

Herrmann and Richter (2003) examined different multiples (P/E, EV/EBIAT, EV/EBIDAAT, P/B, EV/IC, and EV/S) for European non-financial firms. They asserted, consistent with the results of Liu, Nissim and Thomas (2007), that: 1. multiples based on earnings lead to the highest prediction accuracy; and 2. sales multiples yield the lowest prediction accuracy. However, they discovered that the P/B multiple performed better than the EV/EBIDAAT multiple when comparable firms were selected based on ROEs and earnings growths instead of only the industry membership.

Another study that used European data and investigated the relative performance of different multiples is that of Schreiner (2007). He found that: 1. equity value multiples outperform entity value multiples; 2. knowledge-related multiples outperform traditional multiples in science-based industries; and 3. forward-looking multiples outperform trailing multiples. The trailing multiples from Schreiner (2007) are in the following decreasing order from the viewpoint of accuracy: earnings multiples (P/E, P/EBT, P/EBIT, and P/EBITDA), cash flow multiples (P/OCF and P/Dividends), book value multiples (P/IC, P/B, P/TA) and gross income and sales multiples. The performance measures at the basis of the previous hierarchy were the median absolute valuation error and fraction of absolute valuation errors below 15 % of the observed market values.

An important direction of the empirical research on valuation using multiples is represented by the selection of comparable firms. Industry membership, the standard approach in research and practice valuation, was used as the selection method for comparable firms in almost all studies I reviewed. However, in some empirical researches were tested selection rules with different proxies for risk, growth and profitability.

Alford (1992) introduced selection rules based on surrogates for growth (ROE) and risk (TA) and selection rules based on pairs of control factors (IND, ROE and TA). The performances of the seven selection rules tested by Alford (1992) are in the following order: IND + ROE, IND, IND + TA, TA + ROE, ROE, MARKET and TA.

Cheng and McNamara (2000) used six selection methods similar to those of Alford (1992), for P/E, P/B and combined P/E-P/B valuation methods. In the case of the P/E valuation method, they revealed for the performances of the six methods the same order as that obtained by Alford (1992). However, in the case of the P/B valuation method, they found different performances for the six methods, these being as follows: IND + ROE, ROE, IND, IND + TA, MARKET, and TA. For P/E-P/B valuation method, Cheng and McNamara (2000) determined the following decreasing order of the six selection methods from the viewpoint of valuation performance: IND, IND + ROE, IND + TA, MARKET, ROE, and TA.

Dittmann and Wiener (2005) tested five of Alford's selection rules for the EV/EBIT valuation method on data from 15 European Union states and the USA. They showed that: 1. TA is the worst selection rule for most countries; 2. the industry membership selection rule is suboptimal for all countries; firms from the comparable group must be chosen based on ROA; 3. in the case of the USA, the UK and Ireland, the best valuation performance is obtained with ROA + TA selection method; 4. for the US data, the ranks of the selection rules based on median absolute prediction error are as follows: ROA + TA, ROA, IND, TA and MARKET.

Another paper focused on different selection rules is that of Fidanza (2008). She analysed four selection criteria as follows: sector, sector + profitability (profitability is measured with ROA), sector + size (size is measured with the natural logarithm of TA), and profitability + size. The medians of absolute valuation errors from her study suggest that the most accurate selection method for all multiples analysed, excepting the EV/EBIT multiple, is generally sector + size.

Herrmann and Richter (2003) identified control factors for growth (g^s and g^p) and profitability (current ROE). They combined these control factors into FUND (method based on the g^s

and the current ROE), FUND^p (method based on the g^p and the current ROE) and FUNDIND^p (method that selects comparable firms from the same industry and at the same time based on the g^p and the current ROE) selection rules for comparable firms. They obtained for all multiples analysed the following ranks of the selection rules: FUND^p, FUNDIND^p, FUND, IND, and MARKET.

3. Research Design

The valuation methods from this study estimate a firm's share price by capitalizing the firm's value driver at the harmonic mean multiple for a set of comparable firms. In the formula below, "i" represents the valuated firm, "j" the set of comparable firms and "t" the time period analysed. Then:

$$\hat{P}_{i,t} = \textit{Value driver}_{i,t} * \textit{harmonic mean}_{j\in\gamma_{i,t}} \left\{ \frac{P_{j,t}}{\textit{Value driver}_{j,t}} \right\} \tag{3.1}$$

where $\hat{P}_{i,t}$ and $\textit{Value driver}_{i,t}$ are the predicted stock price and actual value driver for firm "i" over the time period "t", and are the actual stock price and value driver for the comparable firm "j", $P_{j,t}$ and $\textit{Value driver}_{j,t}$ the harmonic mean capitalisation rate is computed over all firms "j" in the comparable group for "i", $\gamma_{i,t}$. To estimate the firm's share price with the help of entity value multiples, the firm's net debt is deducted from the result of formula (3.1).

The computation of the synthetic multiple (the capitalisation rate) is conducted out of the sample (i.e., the target firm is removed from the group of comparable firms). The harmonic mean is used as a statistical estimator because this leads to the best valuation performances according to the results of the empirical researches of Baker and Ruback (1999), Liu, Nissim and Thomas (2002), and Henschke and Homburg (2008).

In this study, the following two methods of selecting comparable firms are used:

1). IND: The comparable firms are selected from the analysed period's sample on the basis of the CAEN section. If the CAEN section cannot assure a minimum number of four comparable firms, then the MARKET selection rule is applied.[4]

2). ROE: The four firms of the analysed period's sample closest to the target firm in terms of ROE.

Industry membership is the traditional approach for selecting comparable firms used in both practice and academic literature. To verify the results obtained using this selection method, the ROE method of selecting comparable firms has been also applied. The results of a number of empirical researches show that a control factor for profitability leads to higher accuracy. Dittmann and Weiner (2005) showed that the use of ROA grants the best accuracy from all selection methods studied for the EV/EBIT valuation method, including industry membership. Also, Herrmann and Richter (2003) discovered that the accuracies of the selection methods that include ROE as a control factor (FUND^p, FUNDIND^p, FUND) outperform the accuracy of the industry membership selection method.

Dittmann and Maug (2008) enlightened that the percentage error leads to the least biased error when the harmonic mean aggregates the multiples of comparable firms. Based on the before-mentioned finding and on the observation that most of the reviewed empirical studies combine the use of harmonic mean with that of percentage error, for this study the prediction error was computed as follows:

$$e_{i,t} = \frac{\left(\hat{P}_{i,t} - P_{i,t}\right)}{P_{i,t}} \tag{3.2}$$

where and are the predicted share price and actual stock price for firm "i".

[4]A minimum number of four comparables is required in order to be in line with the minimum value of this inferior limit for selection rules with a single control factor found in the reviewed papers. This limitation led to a very small number of comparable groups. The only comparable group that could be made with a CAEN section is that based on section C, "Manufacturing Industry"

The accuracies of valuation methods are assessed using two performance measures, namely the median absolute prediction error and fraction of prediction errors that are less than 15 percent (the row "Fraction within 15 %" in tables II and III). These performance measures are computed separately for each multiple taking into consideration all firm-periods.[5] To check the robustness over time of the results obtained for all observations without distinction by periods, the median absolute prediction errors were also computed for each period.

As a third measure, the assessments of individual multiple valuation methods are based, as in Herrmann and Richter (2003), on the Wilcoxon rank sum test. This test is applied for all the pairs of valuation methods to asses if one method of the pair is statistically superior compared with the other. The magnitude of this test's statistic is used in this study as an indication of whether two valuation methods are statistically different. If two valuation methods are statistically different, the sign of the statistic indicate which one of the pair's valuation methods is statistically superior compared to the other. For this study, the values and the signs of Wilcoxon rank sum test's statistics are obtained applying the test for equality between medians from EViews. This EViews test is applied to absolute prediction errors recorded on all periods followed in this study.

4. Sample

This paper examines the valuation accuracies of seven multiples, out of which five are equity value multiples (P/E, P/B, P/CF, P/S, P/TA) and two are entity value multiples (EV/EBIT and EV/EBITDA). To construct the sample for this study, accounting data are combined with market data. The accounting data were gathered from annual and first half-year financial statements of BSE-listed non-financial firms available on the CNVM and Intercapital Start internet sites.[6] Stock prices were collected from the Intercapital Start internet site.

The accuracies of the multiples are tested over ten annual periods. The first period analysed is 2003 year and the last one is the period consisting of the last half-year of 2007 and the first half-year of 2008. The first period analysed is the 2003 year in spite of the fact that the BSE was launched in 1995 because of two reasons. First, the data that could be gathered for the periods before 2003 year would be not enough for a proper analysis due to the very few firms listed on BSE in these periods. Second, studies including periods before 2003 year, as those of Dragotă and Mitrică (2001, 2004) and Dragotă, Dămian and Stoian (2002), find that Romanian capital market is inefficient in the weak form. This capital market characteristic leads to lower accuracy of valuation by multiples.

The ten annual periods followed in this study are both calendar years and periods consisting of consecutive half-years belonging to different calendar years. These periods include five calendar years, those from 2003 until 2008, and five periods that include half-years belonging to different calendar years.[7] The use of periods consisting of half-years of different calendar years increases the size and relevance of the sample analysed.

The periods formed of half-years of different calendar years are preferable to periods consisting of four consecutive quarters of different calendar years due to the greater public availability of financial data for the first half-year compared to the availability of financial data for the first

[5]The observations of a firm-period include all analysed multiples' values of a given firm for a given period.

[6]All financial data used in this empirical research are based on RAS financial statements. Shifting to IFRS numbers leads to different values of multiples that can change the results of this study. It can be expected that, over time periods when the BSE market is dominated by retail investors, who do not usually have accounting knowledge, the accuracy of IFRS multiples is lower than that of RAS multiples. However, when the BSE market is dominated by institutional investors, multiples based on IFRS numbers are expected to lead to better valuation results.

[7]The five periods consisting of half-years belonging to different calendar years are the following: 1. the period formed of the second half-year of 2003 and the first half-year of 2004; 2. the period that includes the second half-year of 2004 and the first half-year of 2005; 3. the period containing the second half-year of 2005 and the first half-year of 2006; 4. the period consisting of the second half-year of 2006 and from the first half-year of 2007; and 5. the period formed of the second half-year of 2007 and the first half-year of 2008.

quarter and for the third quarter of a calendar year. This greater public availability is due to the more detailed first half-year reporting requirements imposed by CNVM for the issuers of securities.[8]

It can be noticed that in the case of the accrual flow multiples (P/E, P/S, EV/EBIT, and EV/EBITDA) and of the cash flow multiple the analysis made on periods consisting of half-years from different calendar years includes financial data used in the analysis of calendar year periods.[9] However, it must be emphasized that the multiples of the periods formed of half-years of different calendar years bring into the analysis information that is not redundant. The data used for the computation of these multiples sustain this affirmation. The market data used is specific to the periods for which these multiples are computed. Additionally, the financial data of the period consisting of the last two half-years belonging to different calendar years are taken into consideration in the practice of valuation by multiples at the moment when these multiples are used for valuation in the present empirical research (the August month's last trading day of the evaluated stock).[10]

From all available firm-periods are selected only the firm-periods that have positive values drivers for all seven multiples analysed. A number of 366 such firm-periods were identified. To reduce the influence of outliers, firm-periods that have at least one multiple's value placed under the 1 percentile or over the 99 percentile of the multiple's distribution for the entire period followed were excluded from the analysed sample. The final sample obtained after these adjustments contains 335 firm-periods. Taking into account the total number of seven multiples, finally this study uses a sample of 2.345 observations.

Table I presents the mean, median and inter-quartile range of ROE and of the multiples analysed. All multiples' means are greater than the medians, suggesting that the distributions of multiples are positively skewed. An examination of the trend of multiples' means and medians over time reveals a peak recorded in the period that includes the second half-year of 2006 and the first half-year of 2007 and in 2006. ROE presents a sinuous trend over the entire analysed period. This lack of correlation between the trends of multiples and that of the ROE suggests that profitability has a low impact on the multiples' evolution. This evolution is probably mainly driven by the stock price's evolution.

5. Results

5.1. **Prediction errors when comparable firms are chosen based on industry membership.** Descriptive statistics and performance measures of prediction errors for the analysed multiples when comparable firms are selected on the basis of industry membership are summarised in Panel A of Table II. In the bottom part of Panel A of Table II, statistical tests of differences among the valuation methods based on the Wilcoxon rank sum test are shown. A negative t-statistic indicates that the method for the column is more accurate than the method for the row.[11]

Descriptive statistics indicate that the distributions of prediction errors are positively skewed for all multiples. To mitigate the effect of outliers, in this study the conclusions about the

[8]For example, the CNVM's regulation no. 1 from 2006 requires a report for the first half-year that includes, supplementary to the requirements of the quarterly reports, the issuer's balance sheet.

[9]The categories of multiples by which the results presentation for the relative performance of multiples were organized in this study is based on the classifications of multiples from Liu, Nissim and Thomas (2002) and Schreiner (2007).

[10]The use in valuation practice of trailing multiples indicates that the participants to capital market take into consideration financial data of periods that are different from calendar years. A trailing multiple widely used in the practice of equity valuation using multiples is the trailing P/E, computed as the current market price divided by the most recent four quarter's EPS.

[11]The signs of the t-statistics computed with the Wilcoxon rank sum test are based on the mean ranks of the compared methods provided by EViews for testing the equality between medians. If the method from the column has a lower mean rank that the method from the row, then the former valuation method has a superior accuracy and the minus sign was assigned to the t-statistic of this pair.

valuation bias are based on medians of prediction errors. These medians suggest that all multiples yield biased estimates. Medians of prediction errors of all equity value multiples are negative, indicating that equity value multiples tend to undervalue stock prices. The entity value multiples are characterised by positive medians, suggesting a tendency toward overvaluation.

The results obtained when comparable firms are selected on the basis of industry membership indicate that the best valuation performance is assured by the P/CF multiple. The value of its fraction within 15 % indicates clearly a higher valuation performance compared to those of all other multiples. The value of this performance measure for the P/CF is 0.227 while the next best value, for the EV/EBITDA, is only 0.197. The value of median absolute prediction error for the P/CF (0.363) also indicates the best performance. The t-statistics computed with the Wilcoxon rank sum test for the pairs of valuation methods that include P/CF are all statistically significant at a maximum 10 % level and all suggest the superior performance of the P/CF multiple.

The higher accuracy of P/CF, a cash flow multiple, compared to those of earnings multiples (P/E, EV/EBIT, and EV/EBITDA) is consistent with the common perception mentioned by Liu, Nissim and Thomas (2007) according to which operating cash flows are better than accounting earnings at explaining equity valuations. The higher accuracy of the multiple based on cash flows is also consistent with the results of Park and Lee (2003). However, Liu, Nissim and Thomas (2007) present recent studies that reveal the superiority of earnings measures to cash flow measures. Their results for an international sample sustain the superiority of earnings to cash flow measures (operating cash flows and dividends). Liu, Nissim and Thomas obtained similar results for a U.S. sample five years before. An examination of the performance measures for earnings and cash flow multiples from Schreiner (2007) outlines the same superiority of the multiples based on earnings measures (EBITDA, EBIT, EBT, and E) to multiples based on cash flows (operating cash flows and dividends).

The group of accrual flow multiples (P/E, P/S, EV/EBIT, and EV/EBITDA) contains two multiples (EV/EBITDA and P/S multiples) that obtained the same ranks according to both performance measures. As t-statistics computed with the Wilcoxon rank sum test indicate, all multiples from this group have valuation accuracies statistically indistinguishable from those of the other multiples from the same group. Furthermore, the accuracies of accrual flow multiples are statistically indistinguishable from those of book value multiples. However, a notable exception among accrual flow multiples is provided by the P/S multiple that is statistically different from all multiples, except from the EV/EBIT multiple.

The EV/EBITDA multiple's accuracy based on median absolute prediction error (0.367) and fraction within 15 % (0.197) outperforms the accuracies of the other accrual flow multiples. Compared with the multiples from other categories, this multiple obtains a better accuracy than those of book value multiples, but a lower one than that of the cash flow multiple.

The P/S multiple underperforms all multiples from the same category and from the other two categories of multiples according to both performance measures. Compared to all other multiples, it has the highest median absolute error, 0.551, and the lowest fraction within 15 %, 0.096. An inferior valuation performance of the P/S valuation method is indicated by all signs of the statistically significant t-statistics of the pairs that include the P/S multiple.

The worst valuation performance obtained with the P/S multiple is consistent with the rankings of valuation methods resulted in almost all studies focused on the relative performance of multiples. Examples of such studies are those of Liu, Nissim and Thomas (2002), Lie and Lie (2002), Herrmann and Richter (2003), and Schreiner (2007). However, an exception is the study of Park and Lee (2003) that obtains the least accurate valuation performance with the P/E multiple, while the P/S multiple leads only to the second worst valuation performance.

Book value multiples (P/B and P/TA) obtain the third rank among all analysed multiples from the accuracy viewpoint. This rank is assured by the median absolute error of the P/TA multiple (0.437) and by the fraction within 15 % of the P/B (0.170).

Table I. Descriptive statistics of underlying sample (part 1)

Multiple	Descriptive Statistics	Period					
		2003	**h2 2003 h1 2004**	**2004**	**h2 2004 h1 2005**	**2005**	**h2 2005 h1 2006**
	Mean	14.02	17.65	20.43	25.13	25.76	28.13
P/E	**Median**	10.57	11.03	14.48	12.03	18.86	16.43
	IQR	8.98	9.30	12.24	11.14	24.57	20.78
	Mean	0.90	1.06	1.34	1.38	1.54	1.58
P/B	**Median**	0.80	0.94	0.96	1.11	1.09	1.10
	IQR	0.69	0.45	1.42	1.62	1.43	1.78
	Mean	6.03	6.74	8.18	8.02	10.04	10.58
P/CF	**Median**	5.02	6.60	7.13	6.85	7.80	7.81
	IQR	4.64	2.84	4.78	5.80	6.85	7.00
	Mean	0.64	0.73	0.79	0.76	1.15	1.25
P/S	**Median**	0.55	0.53	0.71	0.56	0.79	0.87
	IQR	0.58	0.68	0.81	0.63	0.87	1.01
	Mean	12.12	12.62	16.79	13.79	18.69	20.28
EV/EBIT	**Median**	9.95	10.68	12.52	13.61	15.44	13.98
	IQR	6.41	6.60	9.78	8.36	13.25	12.84
	Mean	7.37	7.95	8.82	8.91	10.62	11.32
EV/EBITDA	**Median**	6.61	7.66	7.88	8.17	10.08	8.85
	IQR	3.80	2.76	6.17	6.44	6.22	5.59
	Mean	0.62	0.68	0.76	0.8	0.97	0.98
P/TA	**Median**	0.57	0.63	0.56	0.68	0.74	0.63
	IQR	0.53	0.34	0.66	0.54	0.73	0.90
	Mean	10.24%	10.65%	9.16%	14.58%	10.39%	10.16%
ROE	**Median**	10.29%	8.41%	8.52%	11.71%	7.69%	8.76%
	IQR	12.12%	8.72%	7.82%	12.15%	9.42%	10.91%
No. of observations		29	29	32	29	37	33

Note: The periods indicate the year whose financial data were used to compute the multiples that are at the basis of determining the predicted price. Share prices used for multiples computation are close prices from the last trading day of May when the period of financial data is a calendar year and the last trading day of August otherwise. IQR represents the interquartile range.

According to t-statistics computed with the Wilcoxon rank sum test, the group's two multiples are statistically indistinguishable. Each book value multiple is also statistically indistinguishable from accrual flow multiples, with the exception of the P/S multiple. Thus, it cannot be concluded about the relative accuracies of two of the most used multiples, the P/B and P/E. Their values of performance measures indicate contradicting conclusions. According to median absolute error, the P/E outperforms the P/B, while according to fraction within 15 % the P/B outperforms the P/E.

Both book value multiples are statistically different from the P/CF and P/S multiples. As the signs of t-statistics suggest, the accuracies of both book value multiples are lower than that of the P/CF multiple, but higher than that of the P/S multiple.

5.2. **Prediction errors when comparable firms are chosen based on the ROE selection method.** Panel B of Table II summarises descriptive statistics and performance measures of prediction errors for the selection of comparable firms based on the ROE selection method. The values of median absolute prediction error and of fraction within 15 % for the two selection methods indicate a better valuation performance in the case of ROE selection method for P/E,

P/B and P/TA multiples. However, the valuation performances of the P/CF and EV/EBITDA multiples are lower when comparable firms are selected on the basis of ROE.

Table I. Descriptive statistics of underlying sample (part 2)

Multiple	Descriptive Statistics	Period				
		2006	h2 2006 h1 2007	2007	h2 2007 h1 2008	Entire Sample
P/E	Mean	40.87	31.14	36.41	20.67	26.57
	Median	24.90	21.96	24.39	17.07	16.63
	IQR	23.20	19.39	24.15	12.04	18.69
P/B	Mean	2.18	2.64	1.53	1.28	1.55
	Median	1.92	2.44	1.14	1.13	1.19
	IQR	1.61	1.78	1.31	0.96	1.37
P/CF	Mean	14.30	16.03	12.62	9.30	10.34
	Median	12.59	14.27	10.21	8.12	8.46
	IQR	9.43	9.44	9.09	6.17	7.60
P/S	Mean	1.88	2.05	1.67	1.34	1.26
	Median	1.58	1.89	1.05	0.91	0.85
	IQR	1.39	1.39	1.81	1.34	1.18
EV/EBIT	Mean	26.33	24.76	26.19	17.48	19.32
	Median	18.93	21.74	21.55	15.58	15.12
	IQR	14.71	16.88	13.71	8.09	12.55
EV/EBITDA	Mean	14.72	15.53	13.20	10.28	11.02
	Median	13.09	13.74	11.29	9.68	9.78
	IQR	7.08	9.31	7.16	4.71	6.24
P/TA	Mean	1.37	1.64	0.99	0.80	0.97
	Median	1.31	1.62	0.85	0.68	0.77
	IQR	0.94	1.21	0.92	0.57	0.87
ROE	Mean	9.72%	12.84%	8.28%	9.17%	10.37%
	Median	7.73%	10.84%	6.38%	6.14%	8.41%
	IQR	9.55%	11.35%	9.63%	9.98%	10.69%
No. of observations		36	30	42	38	335

Note: The periods indicate the year whose financial data were used to compute the multiples that are at the basis of determining the predicted price. Share prices used for multiples computation are close prices from the last trading day of May when the period of financial data is a calendar year and the last trading day of August otherwise. IQR represents the interquartile range.

Descriptive statistics indicate, as in the case when comparable firms were selected on the basis of industry membership, that the distributions of prediction errors for all multiples are positively skewed. Medians of prediction errors of all equity value multiples indicate a negative valuation bias while medians of the entity value multiples suggest positive valuation bias. Thus, the tendencies previously found toward undervaluation of estimations with equity value multiples and toward overvaluation of estimations with entity value multiples are confirmed.

As the two performance measures show, the accrual flow multiples' group (P/E, P/S, EV/EBIT, and EV/EBITDA) includes the multiple with the highest accuracy (P/E) and the multiples with the lowest three accuracies (P/S, EV/EBIT, and EV/EBITDA) from those of all the analysed multiples. The P/E multiple has the lowest median absolute error (0.358) and, together with the P/B multiple, the highest fraction within 15 % (0.227). The P/S multiple is the worst performer according to both median absolute error (0.568) and fraction within 15 % (0.137). The EV/EBIT and EV/EBITDA multiples have better accuracies than that of the P/S, but lower than those of all other multiples according to both performance measures.

Table II. Prediction errors computed with percentage error
Panel A. Prediction errors based on harmonic means of firms from the same industry

	Multiple						
	P/E	**P/B**	**P/CF**	**P/S**	**EV/ EBIT**	**EV/ EBITDA**	**P/TA**
Descriptive statistics							
Mean	0.004	-0.003	-0.021	-0.043	0.498	0.522	-0.020
Median	-0.185	-0.200	-0.151	-0.367	0.269	0.243	-0.273
Performance measures							
Mean absolute error (MAE)	0.548	0.532	0.441	0.639	0.737	0.702	0.555
Median absolute error (MeAE)	0.457	0.491	0.363	0.551	0.454	0.367	0.437
Fraction within 15%	0.167	0.170	0.227	0.096	0.155	0.197	0.164
Rank based on MeAE	5	6	1	7	4	2	3
Rank based on fraction within 15 %	4	3	1	7	6	2	5
Wilcoxon values							
P/B	0.477						
P/CF	3.789***	3.570***					
P/S	-2.753**	-3.373***	-6.863***				
EV/EBIT	-1.015	-1.404	-4.331***	1.537			
EV/EBITDA	0.496	0.156	-2.457**	2.950**	1.502		
P/TA	0.534	0.030	-3.402***	3.416***	1.360	-0.293	

Note: */**/*** represent significance at the 10 percent/ 5 percent/ 1 percent level. The level of significance for the equality between the medians of selection methods is based on two-sample Wilcoxon rank sum test. A negative t-statistic computed using Wilcoxon rank sum test indicates that the method for the column is more accurate than the method for the row.

The magnitudes of t-statistics computed with the Wilcoxon rank sum test for pairs of accrual flow multiples are statistically significant only for pairs that include the P/E multiple. As the signs of statistically significant t-statistics show, the P/E multiple outperforms the other accrual flow multiples. However, magnitudes of t-statistics indicate that the P/E multiple is statistically indistinguishable from the cash flow multiple and book value multiples. The comparison of the other accrual flow multiples (P/S, EV/EBIT, and EV/EBITDA) with multiples from other categories based on values of t-statistics leads to the conclusion that these accrual flow multiples are statistically less accurate.

Book value multiples (P/B and P/TA) obtain the next accuracy after that of the P/E multiple according to the two performance measures. This affirmation is sustained by the values of performance measures of the P/B multiple (0.363 for median absolute error and 0.227 for fraction within 15 %) and by the value of median absolute error of the P/TA multiple (0.363). The magnitude of t-statistic computed with the Wilcoxon sum rank test for the pair formed by the two book value multiples indicates the fact that these are statistically indistinguishable each from another. The book value multiples are statistically different only from accrual flow multiples other than the P/E multiple. Their accuracies are higher than those of these multiples. The accuracies of two of the most used multiples, the P/B and P/E, can be compared only

based on their median absolute prediction errors, because their fractions within 15 % are equal (0.227). Median absolute prediction errors suggest a better performance for the P/E multiple.

The accuracy of the cash flow multiple is now placed after those of book value multiples. Its median absolute error is 0.387 and its fraction within 15 % is 0.215. Magnitudes of t-statistics computed with the Wilcoxon rank sum for the pairs of valuation methods that include the P/CF are statistically significant at a maximum 10 % only for pairs made by this multiple with accrual flow multiples other than the P/E multiple. The signs of the statistically significant t-statistics enlighten a superior performance in favour of the P/CF multiple.

Table II. Prediction errors computed with percentage error

Panel B. Prediction errors based on harmonic means of firms selected with ROE method

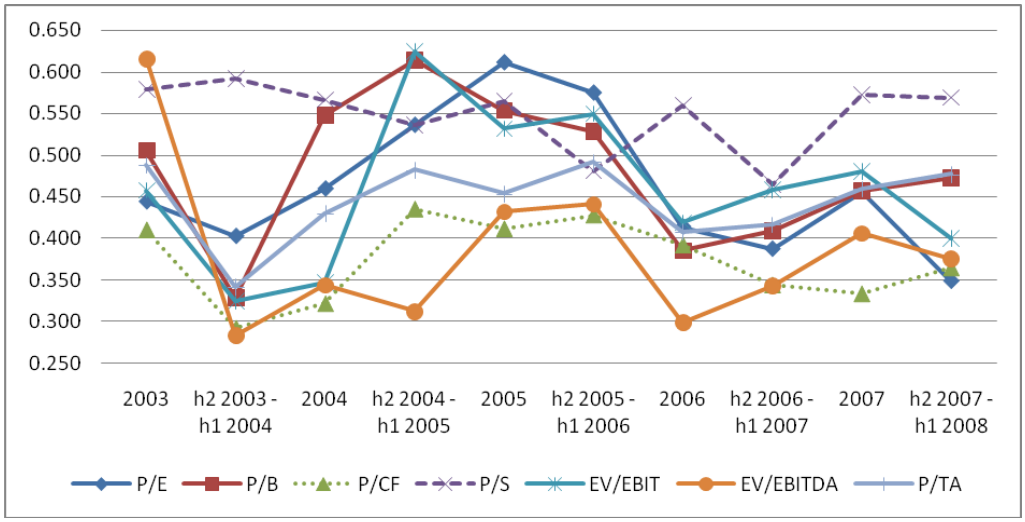
	Multiple						
	P/E	**P/B**	**P/CF**	**P/S**	**EV/ EBIT**	**EV/ EBITDA**	**P/TA**
Descriptive statistics							
Mean	0.053	0.034	0.079	0.163	0.652	0.625	0.076
Median	-0.093	-0.098	-0.081	-0.142	0.294	0.290	-0.095
Performance measures							
Mean absolute error (MAE)	0.451	0.433	0.494	0.706	0.837	0.807	0.501
Median absolute error (MeAE)	0.358	0.363	0.387	0.568	0.455	0.399	0.363
Fraction within 15%	0.227	0.227	0.215	0.137	0.197	0.176	0.209
Rank based on MeAE	1	3	4	7	6	5	2
Rank based on fraction within 15 %	1	1	3	7	5	6	4
Wilcoxon values							
P/B	0.240						
P/CF	-0.724	-0.949					
P/S	-5.735***	-5.971***	-5.104***				
EV/EBIT	-3.620***	-3.840***	-3.025**	1.282			
EV/EBITDA	-3.472***	-3.684***	-2.755**	1.285	0.141		
P/TA	-0.745	-0.991	-0.078	5.090***	2.945**	2.835**	

Note: */**/*** represent significance at the 10 percent/ 5 percent/ 1 percent level. The level of significance for the equality between the medians of selection methods is based on two-sample Wilcoxon rank sum test. A negative t-statistic computed using Wilcoxon rank sum test indicates that the method for the column is more accurate than the method for the row.

5.3. **Prediction errors over time and prediction errors computed with different error and statistical measures.** The accuracies over time of different valuation methods, based on median absolute prediction errors computed separately for each period followed, are plotted in Figure 1 for the industry membership selection method and in Figure 2 for the ROE selection method. There are periods when the performances of different valuation methods were quite close. For the industry membership selection method, such periods were the following: 1. the period consisting of the second half-year of 2005 and the first half-year of 2006; and 2. the period consisting of the second half-year of 2006 and the first half-year of 2007. For the ROE selection method, closer valuation performances of multiples were recorded in 2006 and in the

period formed of the second half-year of 2006 and the first half-year of 2007. However, in the great majority of periods the dispersion of the performances of different valuation methods was wide. This fact proves the importance of the right choice of the multiple for equity valuation using multiples.

Figure 1. Median absolute prediction errors based on harmonic means of firms from the same industry



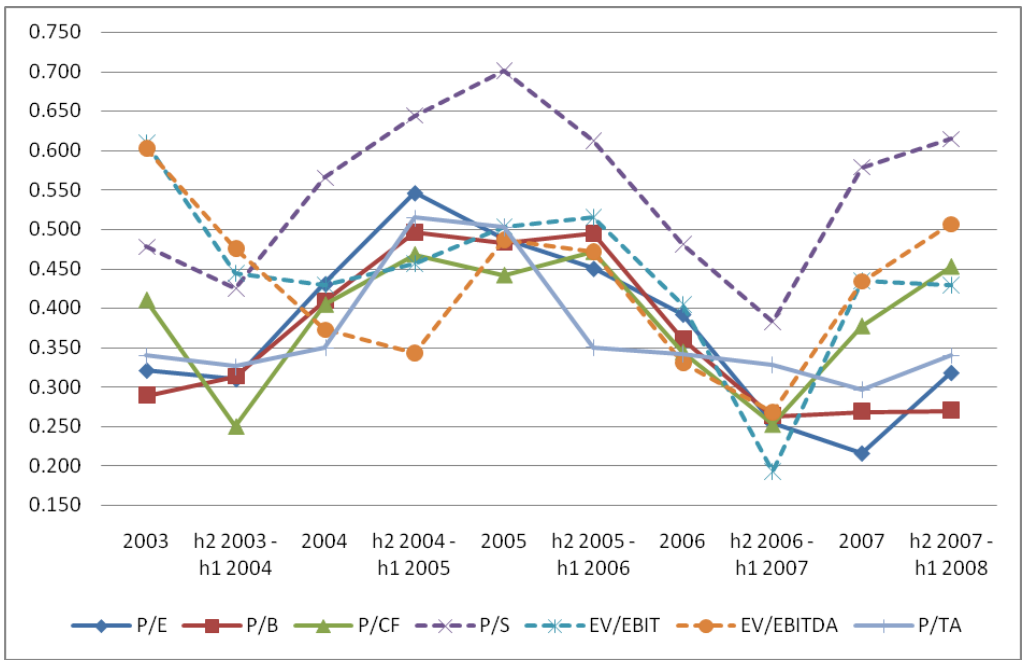
The relative levels of median absolute prediction errors for different valuation methods appear inconsistent over time. However, the results for the case when the comparable firms are selected based on industry membership, without distinction by periods, are generally confirmed by Figure 1. This figure shows the P/CF multiple on the first place from the viewpoint of valuation accuracy in five periods from ten. It follows the EV/EBITDA multiple which has the best accuracy in four periods. The P/S multiple has the worst accuracy in six periods. The ranks of multiples based on the arithmetic mean of the medians of absolute prediction errors of each period sustain at their turn the results presented before. The P/CF multiple has the arithmetic mean of the medians of absolute prediction errors 0.373, the EV/EBITDA multiple 0.385, the P/TA multiple 0.445, the EV/EBIT multiple 0.459, the P/E multiple 0.463, the P/B multiple 0.480, and the P/S multiple 0.549.

The same concordance with the results obtained before can be observed analysing Figure 2. In seven periods out of ten, one of the P/E, P/B, P/CF and P/TA multiples yields the best accuracy from all valuation methods, and in eight periods the second best accuracy. The P/S valuation method leads to the worst valuation performance in eight periods. The EV/EBIT multiple leads to the lowest accuracy in only one period, but determines the second worst accuracy in five periods. The EV/EBITDA multiple is the worst performer in only one period, but the second worst in two periods. The first four ranks of multiples based on the arithmetic mean of the medians of absolute prediction errors of each period sustain again the results mentioned before. The P/B multiple has the arithmetic mean of the medians of absolute prediction errors 0.365, the P/TA multiple 0.369, the P/E multiple 0.372, the P/CF multiple 0.388, the EV/EBITDA multiple 0.429, the EV/EBIT multiple 0.442, and the P/S 0.548.

Supplementary to checking the robustness of the results against time variation, it was verified in this study whether the results are unique to the error and statistical measures used. Logarithmic error represents an error measure widely used in empirical research on multiples valuation. This measures prediction error as the natural logarithm of the ratio of predicted price to actual price. Using the logarithmic error as the error measure and the median as the

estimator, a combination widely used in the empirical research on valuation using multiples, the results are consistent with the results presented before (see Table III).[12]

Figure 2. Median absolute prediction errors based on harmonic means of firms selected by applying the ROE rule



Additionally, when comparable firms are selected based on industry membership, the EV/EBITDA multiple is now statistically more accurate than P/E, P/B, and EV/EBIT multiples. Also, the t-statistic computed with the Wilcoxon rank sum test is statistically significant at a 5 % level for the pair P/S and EV/EBIT multiple. The latter multiple presents a superior performance, consistent with the ranks based on the two performance measures analysed. When comparable firms are selected based on the ROE selection method, the only differences to the results presented in the section 5.2 are that t-statistics computed with the Wilcoxon rank sum test indicate now that the EV/EBIT and EV/EBITDA are statistically more accurate than the P/S multiple.

5.4. **Absolute performance of the valuation by multiples for Romanian firms.** The performance measures computed in this study allow the comparison of its results with corresponding results of other empirical researches that use percentage error and harmonic mean. Dittmann and Weiner (2005) report the mean and median absolute prediction errors of the EV/EBIT valuation method for 15 comparables selection methods (pairs composed of five selection rules and three comparables pools) for each of the 15 European countries and the United States. Almost all of their means indicate better valuation performances than those from the present study. In the case of the median, similar superior results in the favour of foreign firms' valuations can be noticed. However, in this case there is recorded a greater number of exceptions that indicate lower accuracies of foreign firms' valuations. Medians for firms from Luxemburg and Germany when the comparables pool is composed of firms from the same country show lower accuracies than those obtained for the Romanian firms in the present empirical research. The same result is suggested by the medians of the firms from Greece when the comparables

[12]Dittmann and Maug (2008) assert that the median is unbiased in large samples when the logarithmic error measures the prediction errors.

pool is formed of firms from the same region and OECD. For all selection methods, both performance measures indicate better accuracies than those obtained in the present empirical research for firms from the United States, Ireland, Finland, Sweden, Spain, and the Netherlands.

Table III. Prediction errors computed with logarithmic error
Panel A. Prediction errors based on median of firms from the same industry

	Multiple						
	P/E	**P/B**	**P/CF**	**P/S**	**EV/ EBIT**	**EV/ EBITDA**	**P/TA**
Descriptive statistics							
Mean	-0.117	-0.028	-0.058	-0.038	0.324	0.340	-0.018
Median	-0.049	-0.013	-0.038	-0.095	0.354	0.314	-0.066
Performance measures							
Mean absolute error (MAE)	0.624	0.555	0.442	0.690	0.579	0.518	0.558
Median absolute error (MeAE)	0.472	0.507	0.384	0.602	0.487	0.385	0.473
Fraction within 15%	0.161	0.164	0.206	0.119	0.167	0.179	0.146
Rank based on MeAE	3	6	1	7	5	2	4
Rank based on fraction within 15 %	5	4	1	7	3	2	6
Wilcoxon values							
P/B	0.654						
P/CF	4.268***	3.842***					
P/S	-2.495**	-3.366***	-6.875***				
EV/EBIT	0.541	-0.128	-3.827***	3.132**			
EV/EBITDA	2.483**	1.752*	-1.848*	4.921***	1.953*		
P/TA	0.800	0.180	-3.544***	3.495***	0.316	-1.583	

Note: */**/*** represent significance at the 10 percent/ 5 percent/ 1 percent level. The level of significance for the equality between the medians of selection methods is based on two-sample Wilcoxon sum rank test.

A negative t-statistic computed using Wilcoxon rank sum test indicates that the method for the column is more accurate than the method for the row.

This inferior performance of valuation by multiples for Romanian firms is also suggested by the mean absolute valuation errors obtained by Yoo (2006), who applied the industry membership selection method for a sample of United States firms. Mean absolute valuation errors of Yoo (2006) are: 1. 0.600 for the P/S multiple, while in this study 0.639 is obtained by using the industry membership selection method and 0.706 using the ROE selection method; and 2. 0.345 for the P/E multiple, compared with 0.548, respectively 0.451. For the P/B multiple, Yoo (2006) shows a mean absolute valuation error of 0.448. This is lower than the mean of 0.532 from this study, obtained with the industry membership selection method, but higher than the 0.433 mean of the ROE selection method. Using industry membership selection method on a sample of United States firms, Dittmann and Maug (2008) obtained for the P/E multiple the mean of absolute percentage errors of 0.937 and the median of absolute percentage errors of 0.404, and for the P/B multiple the mean 0.712 and the median 0.461. The comparison of the

values of performance measures obtained in the present study for industry membership selection method with the results reported by Dittmann and Maug (2008), indicate a superior valuation performance for United States firms only in the case of medians. In the case of means, the comparison before mentioned reveals lower performances for US firm's valuations.

Table III. Prediction errors computed with logarithmic error

Panel B. Prediction errors based on median of firms selected with ROE rule

	Multiple						
	P/E	**P/B**	**P/CF**	**P/S**	**EV/ EBIT**	**EV/ EBITDA**	**P/TA**
Descriptive statistics							
Mean	0.022	0.000	0.021	0.030	0.385	0.379	0.019
Median	-0.001	-0.025	0.029	0.088	0.375	0.360	0.045
Performance measures							
Mean absolute error (MAE)	0.458	0.441	0.483	0.746	0.573	0.565	0.486
Median absolute error (MeAE)	0.380	0.352	0.399	0.646	0.467	0.441	0.382
Fraction within 15%	0.212	0.206	0.188	0.125	0.194	0.158	0.191
Rank based on MeAE	2	1	4	7	6	5	3
Rank based on fraction within 15 %	1	2	5	7	3	6	4
Wilcoxon values							
P/B	0.360						
P/CF	-0.936	-1.316					
P/S	-6.748***	-7.174***	-5.960***				
EV/EBIT	-2.787**	-3.104**	-1.930*	3.938***			
EV/EBITDA	-2.729**	-3.095**	-1.849*	4.123***	-0.112		
P/TA	-0.965	-1.430	-0.059	5.937***	1.880*	1.780*	

Note: */**/*** represent significance at the 10 percent/ 5 percent/ 1 percent level. The level of significance for the equality between the medians of selection methods is based on two-sample Wilcoxon sum rank test.

The values of performance measures when logarithmic error and median were used allow the comparison of the accuracies of valuation methods from this study with those reported in other studies that used the same error measure and statistical estimator. The results of such studies indicate almost all higher accuracies of the P/E and P/B valuation methods than those obtained in the present study.[13] While in the present study the median absolute prediction errors (fraction within 15 %) for the P/E valuation method range from 0.380 (0.161) to 0.472 (0.212), the same performance measures range from 0.334 (0.250) to 0.342 (0.255) in Lie and Lie (2002). The same performance measures range from 0.266 (0.225) to 0.365 (0.309) in Herrmann and Richter (2003), and from 0.000 to 0.017 in Fidanza (2008). The fraction within 15 % is 0.421 in Deloof et al. (2002). Median absolute prediction errors of the P/B valuation method

[13]A study that reports lower accuracies is that of Kim and Ritter (1999). When interpreting the lower accuracy indicated by the results of Kim and Ritter (1999), it must be taken into account that these are associated to valuing IPOs with the help of the historical number of recent IPOs as comparables. Those numbers are characterised by a great variation that lowers their predictive value.

range from 0.352 to 0.507 in this study, while in Herrmann and Richter (2003) they range from 0.317 to 0.487 and in Fidanza (2008) from 0.001 to 0.069.

A possible explanation for the better accuracies reported by the other comparable studies can be based on the fact that these have drawn their samples from more developed capital markets, whose degree of capital market efficiency is higher. Another explanation can be associated with the greater sizes of the firms from the other papers' samples. Alford (1992), Cheng and McNamara (2000) and Lie and Lie (2002) underline the fact that the valuation accuracy increases with the firm size.

6. Conclusions

In this paper is compared the valuation performance of various multiples (P/E, P/B, P/CF, P/S, P/TA, EV/EBIT and EV/EBITDA) used to estimate the value of Romanian non-financial companies. As selection methods for comparable firms, it was appealed to the industry membership and the ROE selection methods. The sample of this study consists of 335 firm-periods, based on annual financial data collected each half-year beginning with the end of 2003 until the first half-year of 2008 for non-financial firms traded at the BSE.

When comparable firms are selected based on industry membership, this study's results indicate that the best accuracy is determined by the P/CF multiple. T-statistics computed with the Wilcoxon rank sum test for each pair of valuation methods indicate that only the P/CF valuation method is statistically different from all other valuation methods analysed. The P/S multiple is statistically different from all other valuation methods, except for the EV/EBIT valuation method. The P/S multiple has a lower accuracy than those of the valuation methods compared to which it is statistically different. The previous results are obtained using percentage error as error measure and harmonic mean as statistical measure. Evidences that show the worst performance of the P/S multiple and the second best accuracy for the EV/EBITDA multiple among all multiples analysed are identified supplementary when the error measure and the statistical estimator are changed to logarithmic error and respectively median.

When the ROE is used for selecting comparable firms, the performance measures on which this study is focused indicate superior valuation performances of P/E, P/B, P/CF and P/TA multiples to those of the other three multiples, namely P/S, EV/EBIT and EV/EBITDA multiples. T-statistics computed with the Wilcoxon rank sum test for each pair of valuation methods show that only the pairs of valuation methods that include only one of the four most accurate valuation methods according to the performance measures on which this study is focused are statistically different. When using the logarithmic error and median, the results mentioned before, obtained with the help of the percentage error and harmonic mean, are supplemented with evidence that indicates that the P/S multiple leads to the worst valuation performance.

The analysis of the median absolute prediction errors computed separately for each period followed, reveals that the relative performances of multiples are inconsistent over time. However, the relative performances of multiples for each period confirms in a significant measure the relative performances of multiples determined without distinction by periods.

A comparison of this study's absolute performance results with results from other studies generally enlightens lower accuracies of the multiple valuation methods applied on BSE-listed firms relative to those of other empirical researches focused on firms from more developed capital markets. This situation can be explained by a lower degree of capital market efficiency on the Romanian capital market and by the smaller sizes of Romanian firms.

For participants in the Romanian capital market, this study brings three main findings that can prove useful for valuing BSE-listed non-financial firms using multiples: 1. When industry membership is used as a selection method for comparable firms, the P/CF multiple can lead to the best valuation performance; 2. When the ROE is the selection method used, P/E or P/B multiple can assure the best accuracy; and 3. The use of the P/S multiple must be avoided.

A caveat of this study is the poor result of the selection of comparable firms by CAEN division or sector, reflected in a very small number of comparable groups of firms. The identification of another selection criterion for industry membership could be a direction of study that can improve the results of this study's empirical research. A shift from RAS to IFRS numbers for value drivers of multiples can lead to a change in the relative performance of multiples. This change deserves to be further investigated.[14]

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Appendix

Abbreviations and Definitions of Variables

Abbreviations:

Price and value:

EV: Enterprise value per share
P: Share price

Variables used to construct multiples:

[14]This last promising direction of study is suggested by an anonymous referee. For this suggestion and many others, I am grateful to the anonymous referees of this paper and to the Editorial Board of *Review of Banking and Finance*.

B:	Per share book value of equity
CF:	Per share cash flow
E/EPS:	Per share earnings
EBT:	Per share earnings before taxes / pre-tax income
EBIT:	Per share earnings before interest and taxes
EBITDA:	Per share earnings before interest, taxes, depreciation, and amortisation
EBIDAAT:	Per share earnings before interest, depreciation, and amortisation after taxes
IC:	Per share invested capital
OCF:	Per share operating cash flow
S:	Per share sales
TA:	Per share total assets

Additional abbreviations:

BSE:	Bucharest Stock Exchange
CAEN:	Codes of Activities from National Economy
CNVM:	Romanian National Commission of Securities
IFRS:	International Financial Reporting Standards
IND:	Industry
IPO:	Initial Public Offering
g^s:	geometric mean of the historic annual sales growth rates of the preceding four years
g^p:	I/B/E/S long-term growth forecasts for earnings per share
OECD:	Organization for Economic Cooperation and Development
RAS:	Romanian accounting standards
ROA:	Return on assets
ROE:	Return on equity

Definition of Variables:

Appendix A describes in this section how the variables used to compute multiples in this study are defined. Financial data is obtained from the financial statements of BSE-listed firms, posted on the CNVM and Intercapital Start internet sites. From the latter internet site, share prices are also extracted.

All variables below are expressed on a per share basis. The values below (with the exception of P) are deflated by the shares outstanding as of the date when the share price used in multiple computations was gathered. The data for establishing the shares outstanding are taken from the BSE internet site.

This empirical research contains values of variables from ten annual periods gathered each semester. The beginning period is the year 2003 and the last period is that formed of the second half-year of 2007 and the first half-year of 2008. The values of all balance sheet variables (except TA) and of income statement variables for calendar years are extracted directly from financial statements. The values of income statement variables for the periods consisting of two half-years from different calendar years were computed as the sum of the two values of variables for each half-year. The value for the second half-year is computed by subtracting the first half-year value from the calendar year value. The value for the first half-year is extracted directly from the income statement of the first half-year.

Value drivers used to compute entity value multiples:

EBIT:	The sum of the values of gross income and interest expense, taken from the income statement, deflated by shares outstanding
EBITDA:	The sum of the EBIT and the income statement values of depreciation and amortisation, deflated by shares outstanding

Market price variables:

P:	Close price of a share on the last trading day of May/August. In the case of multiples computed with financial data of a calendar year, the target firm's close price on the last trading day of May is taken into consideration. When financial data of periods consisting of two half-years from different calendar years are used, the target firm's close price on the last trading day of August is taken into consideration. This method of selecting the stock prices is established in order to have share prices that all incorporate the data from the last financial statements.
EV:	The enterprise value is computed as the sum of the firm's market value of common equity (P multiplied by the shares outstanding) and the value of the firm's net debt, deflated by shares outstanding. The net debt is calculated as the difference between the balance sheet values of total debt and cash and cash equivalents.

Value drivers used to compute equity value multiples:

E:	Net income from income statement, deflated by shares outstanding
B:	Shareholder's equity from balance sheet, deflated by shares outstanding
CF:	The sum of the values of net income and depreciation and amortisation, taken from the income statement, deflated by shares outstanding
S:	Net turnover from income statement, deflated by shares outstanding
TA:	The sum of the values of fixed assets, current assets and prepaid expenses, taken from the balance sheet, deflated by shares outstanding