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Fundamental Adjustments of Multiples as a Tool to the Business Valuation Accuracy Improvement

Ilya Gurov ✉
Doctor of Science in Economics, CFA,
Associate professor, Head of Finance and Credit Department, Faculty of Economics,
Lomonosov Moscow State University, Moscow, Russia,
ingurov@mail.ru,mailto:kell56@yandex.ru ORCID

Aleksandr Bochkarev
Assistant professor, Finance and Credit Department, Faculty of Economics,
Lomonosov Moscow State University, Moscow, Russia,
bochkarews@mail.ru, ORCID

Abstract

The purpose of the article is to assess the accuracy of the multiple adjustments in conditions of significant differences between the target and comparable companies. The article provides formulas for adjustments based on the Gordon model and its modifications for the P/E and EV/EBITDA multiples. The research is based on such methods as analysis, synthesis, and the longitudinal method, modeling, descriptive and regression analysis were performed. Based on a sample of 38 public railway companies from 13 countries from 2017 to 2023, it was shown for the first time that as a result of adjustments to the P/E multiples in a sample of comparable companies, the standard deviation decreases from 28.7 to 1.2, the spread between 90 and 10 percentiles from 42.7 to 3.2, and the EV/EBITDA multiples decreases the standard deviation from 35.6 to 3.3, the spread between 90 and 10 percentiles from 21.2 to 6.2. Adjustments to the cost of capital and its component (in particular, the risk-free rate) lead to a significant 1% decrease in the spread between multiples of comparable companies. Adjustments for differences in the debt burden lead to a significant 10% decrease in the variability of the EV/EVITDA multiple. Adjustments for expected growth lead to an increase in the variability of multiples due to the difficulty of predicting long-term growth rates of companies. Adjustments to the cost of capital increase the accuracy of cost estimates (deviations from market data amount to 0.3 of net income and 0.5 of EBITDA). At the same time, adjustments only for the cost of capital are more accurate than adjustments for both the cost of capital and growth. Nevertheless, adjustments for both cost of capital and growth make it possible to obtain more accurate estimates than based on unadjusted multiples. In practice, it is advisable to adjust for differences in the cost of capital. If it is not possible to accurately estimate the future growth rates of the target and comparable companies, it is advisable to abandon the growth adjustment, or to carry it out only for differences in expected inflation (for companies from different countries).

Keywords: business valuation, comparative valuation, P/E multiple, EV/EBITDA multiple, multiple adjustments, adjusted multiple, justified multiple, railway industry

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Introduction

Accurate business valuation is essential to ensure appropriate investment decisions, particularly, in asset management, mergers and acquisitions and public share placement. A vast body of academic literature is dedicated to valuation [1–4]. In actual practice ongoing business is usually evaluated using the discounted cash flow method [5–7] and the comparable companies method [8–11].

The discounted cash flow method is premised on the company's financial model. It allows for the calculation of a cash flow forecast, for example, dividends, free cash flows for shareholders or the company. In order to apply this method a correct estimate of the discount rate is also needed (required return on equity or the weighted average cost of capital).

The multiple method (it is also often called the analogue company method, comparable company method or comparative valuation) provides an opportunity to estimate the company value by comparing it to other companies similar in terms of the principal features.

One of the key assumptions of the multiple method is a strong resemblance between the target and comparable companies. However, if the differences between the companies are significant it is difficult to apply this method. For example, due to country-related differences (in case of firms from different countries) the companies may differ in project profitability, anticipated business growth, dividend policy, debt burden, exposure to systematic risk, specific risk premiums, cost of capital. These and other factors influence the value of both the target and comparable companies. Therefore, comparative valuation may overestimate or underestimate the target company value. It is possible to increase the accuracy of the valuation obtained through the analogue company method by applying multiple adjustments, provided they eliminate company-specific differences between the target and comparable companies.

Approaches to multiple adjustments acquire a special role when the number of analogue companies is small or when they differ significantly from the target company. The railway industry was chosen for approbation because use of unadjusted multiples will result in material errors in valuations of Russian railway companies for absolute want of domestic public analogue companies. As at the beginning of 2025 the companies which used to be public (including TransContainer[1], Far Eastern Shipping Company[2]) have been delisted. After delisting, shares of Globaltrans are traded only in Kazakhstan,[3] depressing the opportunity of their use as an analogue under the circumstances of capital restrictions.[4] United Wagon Company is not considered as comparable because of its financial troubles within the analyzed period.[5] The major part of public analogues for evaluation of railway companies (not numerous in itself – approximately 40 companies in the global capital markets) is represented by the companies operating abroad with fundamentally different cost factors, in particular, the cost of capital and anticipated growth. On the other hand, according to SPARK, over 3,000 railway companies operate in the Russian economy. Approximately 100 of them earn over RUB 1 billion and about 500 of them have annual revenues ranging from RUB 100 million to RUB 1 billion.[6] They are relevant for valuation due to their active involvement in mergers and acquisitions and for attracting strategic investors in this sphere.[7]

Thus, although researchers really need accurate tools for business valuation the use of multiples has limitations. At the same time, it is non-optimal to use no multiples at all and choose the discounted cash flow method because an overly positive or overly negative cash flow forecast or risk assessment may skew the valuations. The present paper makes an attempt to address this problem by developing multiple adjustments.

The paper consists of three sections. In the first section we present a literature review in the field of business valuation and application of the multiple method. The second section presents derived formulas for multiple adjustments, analysis of special features of these adjustments and compliance with industrial practices as well as data description. The third section sets forth adjustment formulas, assesses accuracy of adjustments and presents conclusions are made.

Literature Review

The issues of business valuation have been studied extensively in the academic and practical literature. However, this topic is still relevant, and numerous published papers are dedicated to it nowadays.

The calculation of the cost of capital is a key component of business valuation (discount rate or the required equity or total capital of the company yield). The discount rate

[1] URL: https://quote.ru/news/article/5f4df7899a79473b0a73436d

[2] URL: https://smart-lab.ru/blog/934422.php

[3] URL: https://www.globaltrans.com/investors/news/detail/2501

[4] In particular, cancelling dividend policy at the same time with delisting of Globaltrans from the Moscow Exchange caused a significant fall of stocks. URL: https://www.rbc.ru/quote/news/article/66d1644b9a794706d6229e77

[5] URL: https://www.vedomosti.ru/business/articles/2021/11/25/897623-pochemu-u-ovk-net-deneg-na-pogashenie-obligatsii

[6] Companies with Russian National Classifier of Types of Economic Activity (OKVED) 52.21.1 Service Activities Incidental to Railway Transportation; OKVED 49.20 Freight Rail Transport; OKVED 49.10 Passenger Rail Transport, Interurban and International; OKVED 30.20 Manufacture of Railway Locomotives and Rolling Stock.

[7] URL: https://www.rbc.ru/business/22/12/2023/658503e49a794752e8dbc8f0

is important not just to implement the discounted cash flow method but also to take into consideration differences between the target and comparable companies applying comparative valuation. Studies by Markowitz [12] and Tobin [13; 14] laid down the groundwork for modern portfolio theory which was further developed by Sharpe [15], Lintner [16] and Mossin [17] resulting in creation of the *CAPM* model that allows to determine the discount rate. Subsequent critical analysis of the *CAPM* model provided new stock yield models [18–22] including the Fama-French model and its modifications [23; 24]. Influence of certain factors, such as environmental and social ones, on the cost of capital studied [25–28]. Theoretical problems were discussed, in particular, the market risk premium puzzle [29–31]. Some studies examined the impact of certain factors, such as the size, liquidity, inflation risks, on the discount rate [32–35]. As a result, now researchers have at their disposal a vast set of methods for evaluation of the cost of capital including those which take into account specifics of the analyzed companies.

Papers by Modigliani and Miller [36; 37] laid the foundation for modern corporate finance. Thereafter, there were discussions in literature about company value formation, tax shields evaluation [38; 39], business value factors [40–42]. Besides, at present there is a consensus concerning the relationship between the total business value and the equity value and the relationship between the weighted average cost of capital and equity and debt capital. A large number of studies consider applications of business valuation [43–45], assessed influence of news on share price [46–48], mergers and acquisitions [49–51], IPO [52].

Some studies examined evaluation of share prices, on provision that a range of suppositions concerning the future business growth rate was fulfilled [2; 3; 53–55]. As a result, concise models were developed, such as the Gordon model, H-model, growth length model where the value depends on a limited number of factors. These models are convenient for development of multiple adjustments.

A vast body of literature is dedicated to the application of the multiple method. Some papers consider the multiples which are best suited for comparison [56], in particular, *EV/EBITDA* and *P/E* multiples are preferred, however, adjustments to other multiples are also considered including *EV*/revenue, *EV/GMV* (gross merchandise volume) and non-financial multiples.

A series of papers analyzed industry-specific features of business [49; 51; 57–59]. Significance of the industry factor for the multiple method justifies considering comparable companies from the same industry. In general, one of the ways to improve the comparable company method is development of approaches to a well-justified selection of analogue companies [60–62]. Depending on the industry, companies may differ to a greater or lesser extent and in general case there are no two identical companies. In actual practice, the analogue company method is usually applied to a series of companies, however, the assumption that the multiple of the evaluated company should equal the median or weighted average of the multiples of comparable companies is ungrounded and is accepted only for want of a more accurate method.

For this reason, another applied method is multiple adjustments. The obtained multiples are called adjusted or justified ones. In academic literature some papers are dedicated to justification and development of multiple adjustments [59; 63–68]. There are three main approaches:

- the one based on expert assessments;
- the one based on regression adjustments where comparable company multiples are used as dependent variables and their values are explained by the performance indicators of these companies (in particular, cost of capital, business growth rate ets.);
- the one based on fundamental adjustments, in particular, Gordon model analysis.

In actual practice, adjustments based on expert assessments are often used. On the one hand, they have an advantage of simplicity and taking into account market participants' opinion. On the other hand, expert adjustments are not strict and have no formal foundation. At the same time, regression and fundamental adjustments are more complex but they provide a theoretical basis. Despite the high relevance of adjustments research, in the present paper we turn our attention to fundamental adjustments because in academic and practical literature their application is understudied. On a number of occasions it is recommended to adjust the revenue or *EBITDA* value to account for differences in financial accounting [69]. Although these approaches are useful, they fail to take into consideration individual differences of comparable companies. Despite a large number of studies dedicated to dividend policy as a business valuation factor [70–73], dividend policy itself is usually not regarded in multiple adjustments [74]. As we are going to show below, in some instances it impairs accuracy of company valuation (both in terms of standard deviation and bias). We will also show that to take into consideration any difference when evaluating companies two alternative adjustment procedures are possible. Moreover, we did not find such division in the published papers. Next, we present our approach and develop adjustment procedures.

Methods and Data

In this paper we develop adjustments for the P/E and EV/EBITDA multiples because they are the most conventional ones for business valuation by means of comparative valuation. On the basis of the valuation presented in the paper we may develop adjustments for other multiples.

We assume that adjustment procedures should be applicable for an analyst acting as follows:

1. The analyst's purpose is to assess the stock value of the target company *T* using the analogue company method.

2. The analyst has data on the P/E and EV/EBITDA multiples for n public comparable companies B_i, i takes on integer values from от 1 to n where n is the number of comparable companies.
3. Comparable companies may differ from each other and the target company in some indicators, in particular, in anticipated growth rate, dividend policy, debt burden, beta, size, specific risk premiums.
4. The analyst has available data on the indicators stated in item 3 concerning the target company and comparable companies.
5. As for shares and the value of comparable companies the capital market is efficient in semi-strong (medium) form.

In the initial form comparable valuation represents a simplification because it is assumed that the target company resembles the aggregate of comparable companies so much that, based on their multiples, we may define the value of the comparable company. According to comparable valuation the assessment of the intrinsic value of a share of the compan $\widehat{V_T} = \theta\left(\frac{P_{B_i}}{E_{B_i}}\right)\bullet E_T$ y T based on the P/E multiple without adjustments is as follows:

$$\widehat{V_T} = \theta\left(\frac{P_{B_i}}{E_{B_i}}\right)\bullet E_T,$$

where θ is the operator which returns the median, weighted average value or the average value after winsorization of multiples $\frac{P_{B_i}}{E_{B_i}}$ for n comparable companies[8].

One of the ways to take into account company-specific features is to use the Gordon model [2; 3; 53], according to which the company intrinsic value may be calculated by the following formula if it is possible to determine the sustainable rate of dividend growth and the constant discount rate:

$$V = \frac{D}{r-g},$$

where V – intrinsic corporate stock value, D – anticipated dividend amount for the next year, r – discount rate for equity, g – expected dividend increment rate.

It is as unrealistic to follow strictly suppositions of the Gordon model as an attempt to assess accurately the company value. However, strict adherence to the suppositions is not necessary for the purposes of the present research because we aim at improving accuracy, not achieving absolute accuracy of the valuation. Therefore, at this stage it is sufficient that the Gordon model in general takes into consideration the principal value factor (dividend yield, anticipated growth, time value of money and risks). Adjustment will also be more accurate if we use other models, in particular, the H-model. However, they will be less succinct and more complex.

Since according to the accepted suppositions, the capital market is effective in the semi-strong form, we may proceed from the premise that the price of a share of each public company B_i will equal its intrinsic value [75–79]:

$$P_{B_i} = V_{B_i},$$

where – market value of a share of the company B_i.

In case of deviations they will be minimum, unbiassed and temporary.

For further transformations we express the expected dividends as follows:

$$D = PR\bullet E,$$

where PR is a share of dividend in the net profits which is allocated to dividend payout, E – expected stock yield next year. Then the share price may be calculated as follows:

$$P = \frac{PR\bullet E}{r-g},$$

so, the *P/E* multiple equals:

$$\frac{P}{E} = \frac{PR}{r-g}.$$

Then we derive multiple adjustments for various cases. For the sake of brevity, we use the index B, instead of B_i, to designate a comparable company, and in the general case the adjusted multiple is calculated for each comparable company.

Adjustment of the multiple $\frac{P}{E}$ for the case of $r_T \neq r_B$, other things being equal

If the target and comparable companies have different cost of capital and are otherwise similar, adjustment is necessary only for the cost of capital r_T:

$$\left(\frac{P_B}{E_B}\right)_{adj} = \frac{PR_B}{r_T - g_B}.$$

Hereinafter $\left(\frac{P_B}{E_B}\right)_{adj}$ designates an adjusted multiple which takes into consideration individual differences of the target company and comparable companies.

In order to express $\left(\frac{P_B}{E_B}\right)_{adj}$ we multiply and divide $\frac{P_B}{E_B}$ by r_T g_B:

$$\frac{P_B}{E_B} = \frac{PR_B}{r_B - g_B}\bullet\frac{r_T - g_B}{r_T - g_B} = \frac{PR_B}{r_T - g_B}\bullet\frac{r_T - g_B}{r_B - g_B} =$$

[8] In some instances, percentiles (for example, 25 and 75) are used to define the range of the multiples' values and other approaches. However, this aggregate of approaches to choosing the θ operator is beyond the scope of the present research and the authors leave the choice of a certain approach to the discretion of the analyst.

$$\left(\frac{P_B}{E_B}\right)_{adj} \bullet \frac{r_T - g_B}{r_B - g_B},$$

so, we obtain the adjusted multiple:

$$\left(\frac{P_B}{E_B}\right)_{adj} = \frac{P_B}{E_B} \bullet \frac{r_B - g_B}{r_T - g_B}. \quad (1)$$

There is an alternative way to derive the adjustment for the considered case. We raise the *P/E* multiple to the –1 power and transform it:

$$\left(\frac{P_B}{E_B}\right)^{-1} = \frac{r_B - g_B}{PR_B} = \frac{r_T - g_B}{PR_B} - \frac{r_T - r_B}{PR_B} =$$

$$= \left(\frac{P_B}{E_B}\right)^{-1}_{adj} - \frac{r_T - r_B}{PR_B},$$

$$\left(\frac{P_B}{E_B}\right)_{adj} = \frac{1}{\left(\frac{P_B}{E_B}\right)^{-1} + \frac{r_T - r_B}{PR_B}}. \quad (2)$$

When suppositions of the Gordon model are strictly fulfilled formulas (1) and (2) are identical. However, in real practice, they deliver different results. Thus, there are two approaches to the adjustment for the multiple concerning the same difference between the target and comparable companies.

In practice it is possible to apply one of them depending on availability of accurate data for adjustments. In the first case the values of the anticipated growth rate are reqiured, in the second case – values of the payout ratio.

We would like to note that in financial literature the share of dividend payout is usually not used in calculations [74], i.e. it is tacitly presumed that $PR_B = 1$. This implies absence of investments when the capital structure is unchanged, and this should correspond to the zero rate of real growth (at which adjustments are also simplified). However, due to cash flows growth caused by inflation and short-term CAPEX-light business models, in actual life these two simplifications are not biunique. In general, as long as in real practice $0 \le PR_B < 1$ disregard of this indicator in calculations will have a significant impact on bias of the adjustment, i.e. it will result in underestimation of the impact of differences in the discount rate on the adjusted multiple.

Adjustment of the multiple $\frac{P}{E}$ for the case of $g_T \neq g_B$, other things being equal

As a rule, the anticipated growth rates of the company differ. So, it is reasonable to consider the case of $g_T \neq g_B$:

$$\left(\frac{P_B}{E_B}\right)_{adj} = \frac{PR_B}{r_B - g_T}.$$

If companies are otherwise identical, similar to the previous item we may show that direct adjustment appears as follows:

$$\left(\frac{P_B}{E_B}\right)_{adj} = \frac{P_B}{E_B} \bullet \frac{r_B - g_B}{r_B - g_T}. \quad (3)$$

Applying the alternative approach we obtain an adjustment for the reverse multiple in the denominator:

$$\left(\frac{P_B}{E_B}\right)_{adj} = \frac{1}{\left(\frac{P_B}{E_B}\right)^{-1} + \frac{g_B - g_T}{PR_B}}. \quad (4)$$

Adjustment of the multiple $\frac{P}{E}$ for the case of $g_T \neq g_B$, $r_T \neq r_B$, other things being equal

The situation when both the cost of capital and expected dividend growth differ is more common. For example, when comparable companies operate in the country, other than the target company's country, differences in risk-free rates and market risk premiums between national capital markets will influence r_T and r_B; differences in inflation in certain countries will influence g_T and g_B, besides, other difference factors are possible. So, under otherwise equal conditions multiple adjustment is also required for r_B and g_B:

$$\left(\frac{P_B}{E_B}\right)_{adj} = \frac{PR_B}{r_T - g_T}.$$

Similar to previous conclusions it is easy to show that:

$$\left(\frac{P_B}{E_B}\right)_{adj} = \frac{P_B}{E_B} \bullet \frac{r_B - g_B}{r_T - g_T}. \quad (5)$$

Applying the alternative approach:

$$\frac{1}{\left(\frac{P_{B_i}}{E_{B_i}}\right)^{-1} + \frac{r_T - r_{B_i}}{PR_{B_i}} - \frac{g_T - g_{B_i}}{PR_{B_i}}}. \quad (6)$$

Detailing of the multiple $\frac{P}{E}$ taking into consideration differences in dividend policy, components of the cost of capital and dividend growth

The components of the multiple $\frac{P}{E} = \frac{PR}{r - g}$ may be detailed. Cost of equity may be represented as follows:

$$r = r_f + \beta \bullet ERP + RP,$$

where r_f is risk-free return, β – beta of a share, ERP – expected market risk premium, RP – specific risk premiums (for example, premium for size, liquidity, specific premiums including those for dependence on the key person and company management, buyers' diversification, product and geographical diversification, marginality stability and predictability, ESG factors [28; 80; 81]).

The expected dividend growth rate may be presented as follows:

$g = ROE \bullet RR,$

where ROE is average expected real profitability (of equity) of investment projects of the company, RR – the share of revenue which the company reinvests.

If corporate governance is effective for minority shareholders $RR + PR = 1$, and the anticipated growth rate may be represented as follows: $g = ROE \bullet (1 - PR)$.

So, the supposition that $RR + PR = 1$ is significant. Such adjustments will be nonapplicable for assessment, in particular, of Surgutneftegaz stocks because this company places a significant part of earnings on deposits.

Thus, we may present in more detail the multiple:

$$\frac{P}{E} = \frac{PR}{r_f + \beta \bullet ERP + RP - ROE \bullet (1 - PR)}.$$

Only the second method is applied to make adjustments of the detailed multiple because it allows to get a succinct form.

Adjustment of the multiple $\frac{P}{E}$ for the case of $g_T \neq g_B$, $PR_T \neq PR_B$, $r_T - r_{fT} - \beta_T ERP_T \neq r_B - r_{fB} - \beta_B ERP_B$, other things being equal

In this case the adjusted multiple equals:

$$\left(\frac{P_B}{E_B}\right)_{adj} = \frac{PR_T}{r_B - r_{fB} - \beta_B ERP_B + r_{fT} + \beta_T ERP_T - g_T}.$$

Raise to the –1 power and transform $\frac{P_B}{E_B}$:

$$\left(\frac{P_B}{E_B}\right)^{-1} = \frac{PR_T}{PR_B} \frac{r_B - r_{fB} - \beta_B ERP_B + r_{fT} + \beta_T ERP_T - g_T}{PR_T} - \frac{-r_{fB} - \beta_B ERP_B + r_{fT} + \beta_T ERP_T + g_B - g_T}{PR_B},$$

So,

$$\left(\frac{P_B}{E_B}\right)_{adj} = \frac{1}{\frac{PR_B}{PR_T}\left(\frac{P_B}{E_B}\right)^{-1} + \frac{g_B - g_T - r_{fB} - \beta_B ERP_B + r_{fT} + \beta_T ERP_T}{PR_T}}. \quad (7)$$

We consider application of comparable valuation for companies from various countries as a special case. If in real terms in national currency we expect similar dividend growth rates of the target and comparable companies ($g_B - g_T = \pi_B - \pi_T$):

$$\left(\frac{P_B}{E_B}\right)_{adj} = \frac{1}{\frac{PR_B}{PR_T}\left(\frac{P_B}{E_B}\right)^{-1} + \frac{\pi_B - \pi_T - r_{fB} - \beta_B ERP_B + r_{fT} + \beta_T ERP_T}{PR_T}}. \quad (8)$$

On the basis of this adjustment one may derive an adjustment for special cases. Thus, Table 2 presents adjustments for $PR_T = PR_B$ and differences in tier cost of capital $((9) - (12))$.

Adjustment of the multiple $\frac{P}{E}$ for the case of ($PR_T \neq PR_B$, $ROE_T \bullet (1 - PR_T) = ROE_B \bullet (1 - PR_B)$), other things being equal

If companies differ only in the share of dividend payout and their growth rates are equal (due to differences in return on investments) the adjusted multiple equals:

$$\left(\frac{P_B}{E_B}\right)_{adj} = \frac{PR_T}{r_B - g_B}.$$

So, we may present it in a succinct form:

$$\left(\frac{P_B}{E_B}\right)_{adj} = \frac{P_B}{E_B} \bullet \frac{PR_T}{PR_B}. \quad (9)$$

Adjustment of the multiple $\frac{P}{E}$ for the case of $g_T \neq g_B$ ($PR_T \neq PR_B$, $ROE_T = ROE_B$), other things being equal

If companies differ only in the share of dividend payout the adjusted multiple equals:

$$\left(\frac{P_B}{E_B}\right)_{adj} = \frac{PR_T}{r_B - ROE_B \bullet (1 - PR_T)}.$$

To express $\left(\frac{P_B}{E_B}\right)_{adj}$ we make the following transformations:

$$\left(\frac{P_B}{E_B}\right)^{-1} = \frac{r_B - ROE_B \bullet (1 - PR_T) + ROE_B \bullet (1 - PR_T) - ROE_B \bullet (1 - PR_B)}{PR_B} \bullet \frac{PR_T}{PR_T},$$

so,

$$\left(\frac{P_{\text{B}}}{E_{\text{B}}}\right)^{-1} = \frac{r_{\text{B}} - ROE_{\text{B}} \cdot (1 - PR_T)}{PR_T} \cdot \frac{PR_T}{PR_{\text{B}}} + \frac{ROE_{\text{B}} \cdot (PR_{\text{B}} - PR_T)}{PR_{\text{B}}}.$$

Consequently:

$$\left(\frac{P_B}{E_{\text{B}}}\right)_{adj} = \frac{PR_T}{PR_{\text{B}}\left(\frac{P_{\text{B}}}{E_{\text{B}}}\right)^{-1} + ROE_{\text{B}} \cdot (PR_T - PR_{\text{B}})}. \quad (10)$$

Adjustment of the multiple $\frac{P}{E}$ for the case when $g_T \neq g_B$ ($PR_T = PR_B, ROE_T \neq ROE_B$), other things being equal

To consider the cases when companies differ in the expected dividend growth rate we assume that companies have different investment projects' returns. If companies are otherwise equal it is necessary to make multiple adjustment only for ROE because other indicators represent the specific character of the company T rather accurately:

$$\left(\frac{P_B}{E_{\text{B}}}\right)_{adj} = \frac{PR_{\text{B}}}{r_{\text{B}} - ROE_T \cdot (1 - PR_{\text{B}})}.$$

To express $\left(\frac{P_B}{E}\right)_{adj}$ we transform $\frac{P_{\text{B}}}{E_{\text{B}}}$:

$$\left(\frac{P_B}{E_{\text{B}}}\right)^{-1} = \frac{r_{\text{B}} - ROE_{\text{B}} \cdot (1 - PR_{\text{B}}) + ROE_T \cdot (1 - PR_{\text{B}}) - ROE_{\text{B}} \cdot (1 - PR_{\text{B}})}{PR_{\text{B}}}.$$

Then:

$$\left(\frac{P_{\text{B}}}{E_{\text{B}}}\right)^{-1} = \left(\frac{P_{\text{B}}}{E_{\text{B}}}\right)^{-1}_{adj} + \frac{(ROE_T - ROE_{\text{B}}) \cdot (1 - PR_{\text{B}})}{PR_{\text{B}}}.$$

Consequently:

$$\left(\frac{P_B}{E_{\text{B}_B}}\right)_{adj} = \frac{1}{\left(\frac{P_{\text{B}}}{E_{\text{B}}}\right)^{-1} + (ROE_{\text{B}} - ROE_T) \cdot \left(\frac{1 - PR_{\text{B}}}{PR_{\text{B}}}\right)}. \quad (12)$$

Adjustment of the multiple $\frac{P_B}{E_B}$ for the case when there is a difference in the debt burden $Lev_{\text{T}} \neq Lev_B$, other things being equal

We use the formula by Hamada [82] which allows to take into consideration the financial leverage effect in the share's beta:

$$\beta = \beta_u \cdot (1 + (1 - MTR) \cdot Lev),$$

where β – beta of company stocks taking into consideration the debt burden (levered beta), β_u – unlevered beta, MTR – marginal tax rate, Lev – debt ratio which equals the ratio of the debt market value to the equity market value.

The formula for the discount rate is as follows:

$$r = r_f + \beta_u \cdot (1 + (1 - MTR) \cdot Lev) \cdot ERP,$$

taking into consideration previously introduced conditions that $\frac{P}{E} = \frac{PR}{r - g}$ it turns out that:

$$\frac{P}{E} = \frac{PR}{r_f + \beta_u \cdot (1 + (1 - MTR) \cdot Lev) \cdot ERP - g}.$$

If the comparable and target companies differ only in the debt burden level the formula is as follows:

$$\left(\frac{P_{\text{B}}}{E_{\text{B}}}\right)_{adj} = \frac{PR_{\text{B}}}{r_{f\text{B}} + \beta_{u\text{B}} \cdot (1 + (1 - MTR_{\text{B}}) \cdot Lev_T) \cdot ERP_{\text{B}} - g_{\text{B}}}$$

To express $\left(\frac{P_B}{E_{\text{B}}}\right)_{adj}$ we transform:

$$\left(\frac{P_{\text{B}}}{E_B}\right)^{-1} = \frac{r_{f\text{B}} + \beta_{u\text{B}} \cdot \cdot (1 + (1 - MTR_B) \cdot Lev_{\text{B}}) \cdot ERP_{\text{B}} - g_{\text{B}}}{PR_{\text{b}}} +$$

$$+ \frac{\beta_{u\text{B}} \cdot (1 + (1 - \text{MTR}_{\text{B}}) \cdot Lev_T) \cdot ERP_{\text{B}} - \beta_{u\text{B}} \cdot (1 + (1 - \text{MTR}_{\text{B}}) \cdot Lev_T) \cdot ERP_{\text{B}}}{PR_{\text{B}}}.$$

So, from $\left(\frac{P_B}{E_B}\right)^{-1}$ we may distinguish the expression of $\left(\frac{P_B}{E_B}\right)^{-1}_{adj}$:

$$\left(\frac{P_B}{E_B}\right)^{-1} = \left(\frac{P_B}{E_B}\right)^{-1}_{adj} + \frac{\beta_{u\,B} \bullet (1 - MTR_B) \bullet (Lev_B - Lev_T) \bullet ERP_B}{PR_B}$$

From which:

$$\left(\frac{P_B}{E_B}\right)_{adj} = \frac{1}{\left(\frac{P_B}{E_B}\right)^{-1} + \frac{\beta_{uB} \bullet\bullet ERP_B \bullet (1 - \mathrm{MTR}_B) \bullet (Lev_T - Lev_B)}{PR_B}}. \quad (13)$$

Adjustment of the multiple $\frac{P_B}{E_B}$ for the case when the tax rate $MTR_T \neq MTR_B$, other things being equal

Similar to the previous item we may show that in case of a difference in the marginal income tax rate:

$$\left(\frac{P_B}{E_B}\right)_{adj} = \frac{1}{\left(\frac{P_B}{E_B}\right)^{-1} + \frac{\beta_{uB} \bullet ERP_B \bullet\bullet Lev_B \bullet (MTR_B - MTR_T)}{PR_B}}. \quad (14)$$

Development of Fundamental Adjustments for the *EV/EBITDA* Multiple

The above adjustments are intended for an improvement in the accuracy of the equity valuation. In real practice they are often made for the business value (including share capital and debt capital). Even if the overall goal is to assess the value of share capital in particular, it may be obtained on the basis of the business value by deducting the debt, minority stake and adding surplus funds. In this respect, on the basis of the valuation verified above, it is reasonable to develop also fundamental adjustments for the multiple of [Enterprise value]/[Earnings before interest, depreciation, tax, amortization] (*EV/EBITDA*).

To develop the adjustments which will provide justified values of the *EV/EBITDA* multiple taking into account the differences in the target and comparable companies we are going to use an extended Gordon model considered, among other things, in [83]:

$$EV = \frac{FCFF}{WACC - q},$$

where EV is the enterprise value, $FCFF$ – free cash flows for the firm for the next year while $WACC$ – weighted average cost of capital, q – average compound rate of $FCFF$ increment.

Suppose $k = \frac{FCFF}{EBITDA}$, right ratio which shows the level of conversion of *EBITDA* to *FCFF*, then the multiple $\frac{EV}{EBITDA}$ may be represented as follows:

$$\frac{EV}{EBITDA} = \frac{k}{WACC - q}.$$

This correlation in terms of structure corresponds to the representation of $\frac{P}{E} = \frac{PR}{r - g}$. We would like to note that in general case one may derive adjustments by adjusting to $WACC$, q, k indicators and their components. Thus, if $WACC_T \neq WACC_B$, other things being equal:

$$\left(\frac{EV_B}{EBITDA_B}\right)_{adj} = \frac{k_B}{WACC_T - q_B}.$$

We derive easily:

$$\left(\frac{EV_B}{EBITDA_B}\right)_{adj} = \frac{EV_B}{EBITDA_B} \bullet \frac{WACC_B - q_B}{WACC_T - q_B} \quad (15)$$

The adjusted multiple may also be deduced by means of alternative transformations:

$$\left(\frac{EV_B}{EBITDA_B}\right)^{-1} = \frac{WACC_T - q_B + WACC_B - WACC_T}{k_B},$$

it follows from here that:

$$\left(\frac{EV_B}{EBITDA_B}\right)_{adj} = \frac{1}{(\frac{EV_B}{EBITDA_B})^{-1} + \frac{WACC_T - WACC_B}{k_B}}. \quad (16)$$

In a similar way we derive multiples for differences in the anticipated growth rates, ratios k and cost of capital (20)–(27) presented in Table 2. To assess influence of the debt burden (28), other things being equal, transformations were carried out starting from the weighted average cost of capital

$$WACC = \left(r_f + \beta_U \bullet ERP\right) \bullet \left(1 - MTR \bullet \frac{Lev}{1 + Lev}\right),$$

it is true in case the debt rate equals the risk-free rate. It is possible to deduce more accurate adjustments but they will be less succinct.

Summarized results of adjusted multiples are represented in analytical form in Tables 1 and 2 in the section Research Results.

Data

To verify the research results we used data about 38 public railway companies from 13 countries for 2016–2023. The data is taken by years. The research uses forward multiples *P/E* and *EV/EBITDA*. Growth rates are calculated on the basis of the blended growth rate formula which weighs forecasts of growth rates for various horizons taking into consideration discount factors [74]. A two-year growth of a corresponding indicator was used as the anticipated short-term growth rate, the anticipated nominal GDP growth rate was used for the long-term growth rate. Consolidated financial statements of companies and macroeconomic and financial statistics, analysts' forecasts were used as the data sources. Descriptive statistics of data are presented in the Appendix (Table 5).

TransContainer was used as the target company. It was chosen because it is a Russian company and now it is of relevance to improve the multiple method for assessment of the target company based on the data from the global capital markets. We calculated adjusted multiples for 38 companies which are comparable for TransContainer.

The adjustment effectiveness was evaluated on the basis of indicators of the adjusted values spread. The following indicators have been used:

- standard deviation of adjusted multiples (conventional measure), annual data from 2018 to 2023;
- spread between the 90th and 10th percentile for 2018–2023. This indicator is chosen because it shows the degree of the sample homogeneity with a 10% data winsorization from the top and bottom.

In the research the calculated standard deviations of adjusted multiples were used as dependent variables to verify statistical significance of improvement of certain adjustments' accuracy. The type of the data structure is panel data (time scale – years, spatial scale – certain types of adjustments). In future studies it is possible to apply other indicators of the adjustments' quality assessment, in particular, valuation of accuracy of the forecasts for the target company value depending on the adjustment.

On the basis of the conducted analysis we advance and verify the following hypotheses:

1. Adjustments allow to eliminate company-specific differences and improve accuracy of assessment using comparative valuation.
2. There are significant differences in influence of certain adjustments on the spread of multiples.
3. Adding to the calculation the share of dividend payout in the net profit and the ratio of the free cash flow for the company to *EBITDA* provides increases accuracy as compared to the case when these indicators are not taken into consideration while making adjustments.
4. Accuracy of direct adjustments (type 1, 3, 5, 13, 18 etc.) and adjustments based on a reverse multiple (type 2, 4, 6, 19 etc.) differ.

Research Results

Our transformations provided the following formulas for adjustment.

Table 1. Fundamental adjustments for the multiple $\frac{P}{E}$

Taking differences into account	Adjusted multiple $\left(\frac{P_B}{E_B}\right)_{adj}$
$r_T \neq r_B$	$\frac{P_B}{E_B} \cdot \frac{r_B - g_B}{r_T - g_B}$ (1) or $\frac{1}{\left(\frac{P_B}{E_B}\right)^{-1} + \frac{r_T - r_B}{PR_B}}$ (2)
$g_T \neq g_B$	$\frac{P_B}{E_B} \cdot \frac{r_B - g_B}{r_B - g_T}$ (3) or $\frac{1}{\left(\frac{P_B}{E_B}\right)^{-1} + \frac{g_B - g_T}{PR_B}}$ (4)
$r_T \neq r_B$ $g_T \neq g_B$	$\frac{P_B}{E_B} \cdot \frac{r_B - g_B}{r_T - g_T}$ (5) or $\frac{1}{\left(\frac{P_B}{E_B}\right)^{-1} + \frac{r_T - r_B + g_B - g_T}{PR_B}}$ (6)
$r_T \neq r_B$, $r_T - r_{fT} - \beta_T ERP_T = r_B - r_{fB} - \beta_B ERP_B$ $g_T \neq g_B$, $PR_T \neq PR_B$	$\frac{1}{\frac{PR_B}{PR_T}\left(\frac{P_B}{E_B}\right)^{-1} + \frac{r_{fT} + \beta_T ERP_T - r_{fB} - \beta_B ERP_B + g_B - g_T}{PR_T}}$ (7)

Taking differences into account	Adjusted multiple $\left(\frac{P_B}{E_B}\right)_{adj}$
$r_T \neq r_B$, $r_T - r_{fT} - \beta_T ERP_T = r_B - r_{fB} - \beta_B ERP_B$, $g_T \neq g_B$, $g_B - g_T = \pi_B - \pi_T$, $PR_T \neq PR_B$	$\frac{1}{\frac{PR_B}{PR_T}\left(\frac{P_B}{E_B}\right)^{-1} + \frac{r_{fT} + \beta_T ERP_T - r_{fB} - \beta_B ERP_B + \pi_B - \pi_T}{PR_T}}$ (8)
$r_T \neq r_B$, $g_T \neq g_B$, $PR_T \neq PR_B$	$\frac{1}{\frac{PR_B}{PR_T}\left(\frac{P_B}{E_B}\right)^{-1} + \frac{r_T - r_B + g_B - g_T}{PR_T}}$ (9)
$r_T - r_{fT} - \beta_T ERP_T \neq r_B - r_{fB} - \beta_B ERP_B$, $g_T \neq g_B$, $g_B - g_T = \pi_B - \pi_T$	$\frac{1}{\left(\frac{P_B}{E_B}\right)^{-1} + \frac{r_{fT} + \beta_T ERP_T - r_{fB} - \beta_B ERP_B + g_B - g_T}{PR_B}}$ (10)
$r_{fT} \neq r_{fB}$, $g_T \neq g_B$	$\frac{1}{\left(\frac{P_B}{E_B}\right)^{-1} + \frac{r_{fT} - r_{fB} + g_B - g_T}{PR_B}}$ (11)
$RP_T \neq RP_B$	$\frac{1}{\left(\frac{P_B}{E_B}\right)^{-1} + \frac{RP_T - RP_B + g_B - g_T}{PR_B}}$ (12)
$PR_T \neq PR_B$, $g_T = g_B$	$\frac{P_B}{E_B} \cdot \frac{PR_T}{PR_B}$ (13)
$PR_T \neq PR_B$	$\frac{PR_T}{PR_B\left(\frac{P_B}{E_B}\right)^{-1} + ROE_B \cdot (PR_T - PR_B)}$ (14)
$ROE_T \neq ROE_B$	$\frac{1}{\left(\frac{P_B}{E_B}\right)^{-1} + (ROE_B - ROE_T) \cdot \left(\frac{1 - PR_B}{PR_B}\right)}$ (15)
$Lev_T \neq Lev_B$	$\frac{1}{\left(\frac{P_B}{E_B}\right)^{-1} + \frac{\beta_{uB} * ERP_B \cdot (1 - MTR_B) \cdot (Lev_T - Lev_B)}{PR_B}}$ (16)
$MTR_T \neq MTR_B$	$\frac{1}{\left(\frac{P_B}{E_B}\right)^{-1} + \frac{\beta_{uB} \cdot ERP_B \cdot Lev_B \cdot (MTR_B - MTR_T)}{PR_B}}$ (17)

Source: compiled by the authors.

Table 2 provides adjustments for the EV/EBITDA multiple.

Table 2. Fundamental adjustments for the multiple $\frac{EV}{EBITDA}$

Taking differences into consideration	Adjusted multiple $\left(\frac{EV_B}{EBITDA_B}\right)_{adj}$
$WACC_T \neq WACC_B$	$\frac{EV_B}{EBITDA_B} \cdot \frac{WACC_B - q_B}{WACC_T - q_B}$ (18) or $\frac{1}{\left(\frac{EV_B}{EBITDA_B}\right)^{-1} + \frac{WACC_T - WACC_B}{k_B}}$ (19)
$q_T \neq q_B$	$\frac{EV_B}{EBITDA_B} \cdot \frac{WACC_B - q_B}{WACC_B - q_T}$ (20) or $\frac{1}{\left(\frac{EV_B}{EBITDA_B}\right)^{-1} + \frac{q_B - q_T}{k_B}}$ (21)
$WACC_T \neq WACC_B$, $q_T \neq q_B$	$\frac{EV_B}{EBITDA_B} \cdot \frac{WACC_B - q_B}{WACC_T - q_T}$ (22) or $\frac{1}{\left(\frac{EV_B}{EBITDA_B}\right)^{-1} + \frac{WACC_T - WACC_B + q_B - q_T}{k_B}}$ (23)
$WACC_T \neq WACC_B$, $q_T \neq q_B$, $k_T \neq k_B$	$\frac{1}{\frac{k_B}{k_T}\left(\frac{EV_B}{EBITDA_B}\right)^{-1} + \frac{WACC_T - WACC_B + g_B - g_T}{k_T}}$ (24)
$WACC_T \neq WACC_B$, $q_T \neq q_B$, $q_T - \pi_T \neq q_B - \pi_B$, $k_T \neq k_B$	$\frac{1}{\frac{k_B}{k_T}\left(\frac{EV_B}{EBITDA_B}\right)^{-1} + \frac{WACC_T - WACC_B + \pi_B - \pi_T}{k_T}}$ (25)
$WACC_T \neq WACC_B$, $WACC_T - r_T = WACC_B - r_B$, $q_T \neq q_B$	$\frac{1}{\left(\frac{EV_B}{EBITDA_B}\right)^{-1} + \frac{r_{fT} - r_{fB} + q_B - q_T}{k_B}}$ (26)
$k_T \neq k_B$, $q_T = q_B$	$\frac{EV_B}{EBITDA_B} \cdot \frac{k_T}{k_B}$ (27)
$Lev_T \neq Lev_B$	$\frac{1}{\left(\frac{EV_B}{EBITDA_B}\right)^{-1} + \frac{Lev_B - Lev_T}{(1+Lev_T)\cdot(1+Lev_{B)}} \cdot \frac{\left(r_{fB} + \beta_{uB} * ERP_B\right)\cdot MTR_B}{k_B}}$ (28)

Source: compiled by the authors.

In real practice, the following formulas may be used for business valuation on the basis of adjusted multiples:

$$\widehat{P_T} = \theta\left(\frac{P_{B_i}}{E_{B_i}}\right)_{adj} \cdot E_T,$$

$$\widehat{EV_T} = \theta\left(\frac{EV_{B_i}}{EBITDA_{B_i}}\right)_{adj} \cdot EBITDA_T,$$

where θ – the operator which returns the median, weighted average value or the average value after winsorization of multiples $\frac{P_{B_i}}{E_{B_i}}$ for n comparable companies.

However, the adjustments themselves may turn out to be ineffective and against expectation degrade the quality of company valuation. This may, in particular, be due to an error in the valuation of adjusting parameters. For example, an inaccurate estimation of the cost of capital, dividend policy or anticipated growth rate of the stock price increment will result in a less accurate estimate of the stock value $\widehat{P_T}$ or business value $\widehat{EV_T}$ than in case of applying the multiple method without adjustments.

Adjusted multiples are calculated in this paper by the formulas presented in Tables 1 and 2 to evaluate effectiveness of the adjustments. In order to calculate influence when the share of dividend payout and the *k* ratio are accounted for incorrectly, we calculated adjustments for $PR_{B_i} = 1$ and $k_{B_i} = 1$ as well as the adjustments where growth rates are replaced with expected inflation values.

The results showed that use of adjustments allows to eliminate company-specific differences and improve accuracy of valuation using comparative valuation.

As long as the main goal of adjustments is elimination of company-specific differences, in our research reduction in the spread of the multiples served as the criterion for effectiveness of adjustment procedures. To assess such spread we applied estimates of multiples' standard deviation for comparable companies and the spread between the 90th and 10th percentiles of such multiples (separately for *P/E* and *EV/EBITDA*).

Table 3. Results of the adjustments which dimmish differences between comparable companies most of all

Multiple		Standard deviation	Spread between the 90th and 10th percentiles
P/E	The best adjustment (2)	1.2	3.2
	Second-best adjustment (6)	6.1	6.5
	No adjustments	28.7	42.7
EV/EBITDA	The best adjustment (19)	3.3	6.2
	Second-best adjustment (25)	6.8	6.7
	No adjustments	35.6	21.2

Source: compiled by the authors.

As we see from Table 3 adjustments allow to decrease standard deviation of multiples for comparable companies 10-fold and even more, the spread between the 90th and 10th percentiles – 3.5 times and more. This decrease is achieved with adjustment 2 for *P/E* and adjustment 19 for *EV/EBITDA* (for differences in the cost of capital). Also, adjustments (6) and (25) diminish significantly the spread of multiples. They take into consideration both the cost of capital and differences in the anticipated growth rates (the above results are obtained by approximation with expected long-term inflation).

Effectiveness of the adjustment depends on the quality of assessing the parameters for which the adjustment is made. Thus, in particular, taking into consideration the size premium by the Duff and Phelps[9] method usinig adjustment (2) entails a decrease in standard deviation by 0.1 p.p. and the spread between the 90th and 10th percentiles – by 0.3 p.p. for the *P/E* multiple (Table 4).

[9] URL: kroll.com (accessed date: 16.06.2025).

Table 4. Results of the adjustments which diminish the differences between the comparable companies

Multiple		Standard deviation	Spread between the 90th and 10th percentile
P/E, the best adjustment (2)	The cost of equity is defined on the basis of the *CAPM* model to which the size premium was added	1.2	3.2
	The cost of equity is defined on the basis of the *CAPM* model	1.3	3.5
EV/EBITDA, the best adjustment (19)	When calculating *WACC* the cost of equity was defined on the basis of the *CAPM* model to which the size premium was added	3.3	6.2
	When calculating *WACC* the cost of equity was defined on the basis of the *CAPM* model	3.6	6.1

Source: compiled by the authors.

In general, calculations showed that adjustments may both diminish the spread of multiples (i.e. to take into consideration effectively individual differences between the target and comparable companies) and increase it. In particular, the spread of multiples may increase when making adjustments for growth because evaluating the anticipated growth rate is complicated.

To assess influence of certain adjustments for diminishing the spread between multiples we evaluated the following regressions:

$$\ln(\sigma_{\frac{P}{E}adj}) = const + b_1 \bullet V_1 + b_2 \bullet V_2,$$

$$\ln(\sigma_{\frac{EV}{EBITDA}adj}) = const + b_1 \bullet V_1 + b_2 \bullet V_2,$$

where $\ln(\sigma_{\frac{P}{E}adj})$ is natural logarithm of standard deviation of adjusted P/E multiples, $\ln(\sigma_{\frac{EV}{EBITDA}adj})$ – natural logarithm of standard deviation of adjusted *EV/EBITDA* multiples, $const$ – constant, V_1 – vector of dummy variables which shows presence of adjustments for the cost of capital, risk-free rate, anticipated growth, expected inflation, differences in the debt burden, differences in anticipated project profitability, differences in dividend policy or free cash flow for the company and *EBITDA*), V_2 – vector of the variables which comprise the value of inflation and risk-free return in Russia and the USA, b_1, b_2 – vectors of evaluated ratios. Application of the natural logarithm of the dependent variable allows to assess the percentage for which use of a certain adjustment changes multiples' standard deviation in the sample of comparable companies.

Table 4 represents the results of valuation of random effects model. In the calculations we used robust standard errors. On the basis of the Breusch-Pagan test we made the conclusions that in models (1) (3) the hypothesis of heteroscedasticity is rejected at the 1% significance level, in model (4) – at the 10% significance level. The hypothesis of residuals normality according to the Pearson test is not rejected at the 1% significance level for models (1)–(3), and the 5% significance level for model (4). To verify robustness of the results we also applied the weighted least-squares method. Different calculation methods have not provided a significant difference in valuations.

Table 5. Results of evaluation of the adjustments' impact on standard deviation of the multiples

Model	(1)	(2)	(3)	(4)
Dependent variable	$\ln(\sigma_{\frac{P}{E}adj})$		$\ln(\sigma_{\frac{EV}{EBITDA}adj})$	
Regressors				
const	6.02***	4.15***	5.11***	4.02***
	(0.60)	(1.08)	(0.79)	(1.05)
Performed adjustment for the cost of capital	-2.21***	-1.69**	-2.07***	-2.10***
	(0.44)	(0.70)	(0.36)	(0.43)
Performed adjustment for the risk-free rate	-1.47***	-1.27*	-1.09***	-1.16***
	(0.51)	(0.66)	(0.42)	(0.43)

Model	(1)	(2)	(3)	(4)
Performed adjustment for the anticipated growth	2.24*** (0.44)	3.38*** (0.35)	1.26*** (0.41)	1.42*** (0.41)
Performed adjustment for the expected inflation	1.34*** (0.43)	2.41*** (0.37)	0.48 (0.35)	0.61** (0.29)
Performed adjustment for the debt burden	1.06** (0.41)	2.57*** (0.79)	-0.70* (0.43)	-0.42 (0.56)
Performed ajustment for the tax rate	-0.58 (0.40)	0.53 (0.67)	-	-
Use of reverse multiple	-0.84** (0.40)	0.04 (0.35)	-1.32*** (0.45)	-0.77*** (0.29)
Error in the adjustment for dividend policy or the k indicator	-	0.39 (0.35)	-	0.43 (0.31)
Interest rate in the USA	34.39*** (7.14)	39.04*** (7.32)	6.24 (8.70)	5.21 (9.80)
Interest rate in Russia	-50.50*** (8.73)	-59.94*** (8.29)	-31.40*** (6.65)	-27.30*** (7.08)
Inflation in the USA	3.13 (8.73)	-0.23 (8.26)	8.24 (7.26)	12.83* (7.25)
Inflation in Russia	16.19*** (4.41)	20.15*** (3.78)	17.36*** (4.12)	13.88*** (4.17)
Observations	204	174	132	114
Akaike criterion	683	573	401	332
Likelihood function logarithm	-329	-274	-190	-154

Note: *, ** and *** mean the 10%, 5% and 1% significance levels, respectively.

Source: calculated by the authors

The obtained results lead us to the conclusion that adjustments for the cost of capital entail statistically significant diminishing of the differences between the multiples of comparable companies at the 1% level. Adjustments for the risk-free rate provide a lesser but significant effect (at the 15 and 10% level depending on the model). These results confirm conclusions of Table 3 which state that adjustments achieve the highest efficiency when differences in the share capital value (for *P/E*) and weighted average cost of capital (for *EV/EBITDA*) are taken into consideration. We should note that current financial theory provides an opportunity to evaluate rather accurately the cost of capital.For this reason the potential errors in calculation of the equity value and weighted average cost of capital influence the adjustment results to the minimum extent.

Growth adjustments, on the contrary, increase the spread of multiples significantly. The reason may be that valuation of the anticipated growth (dividend or cash flow) is a complicated problem. In real practice, even forecast data is often determined on the basis of reporting [84]. Assessment of the anticipated growth rate, even taking into account the approach to calculation of the combined growth rate [74] will show a high error variance. Our analysis shows that attempts to make growth adjustments are highly likely to fail because the applied proxies for the expected growth of dividends or free cash flows for the firm are inaccurate and entail biases in the adjusted multiples' value. So, if there is no way to forecast accurately the growth rate of the target and comparable companies it is reasonable not to apply the growth adjustment. In some instances, the growth adjustment may be replaced with the adjustment for the differences in expected inflation which, however, also fails to provide a significant decrease in the multiples' variance.

Adjustments for differences in the debt burden improve accuracy of valuation of the *EV/EBITDA* multiple. Probably,

accuracy improves because such adjustments allow to take into consideration differences in benefits from tax shields.

In the research we verified the hypothesis on influence of an error when taking into account PR and k (the share of dividend payout or the ratio of the free cash flow for the firm to *EBITDA*). The hypothesis is confirmed partially: an error in taking into consideration the share of dividend payout or the ratio of the free cash flow for the firm to *EBITDA* (i.e. de facto accepting that $PR_{B_i} = 1$ and $k_{B_i} = 1$) entails a decrease in the adjustment effectiveness by 37–42%, however, the dependence is statistically insignificant and the p-value equals 0.22–0.24 for different model specifications. One of the problems with taking into consideration PR and k is that they are difficult to predict for a long term.

As previously stated, in real practice, PR and k are often overlooked when multiples are adjusted. Deducing formulas to adjust the multiple $\frac{EV}{EBITDA}$ we relied upon the ratio of $FCFF = EBITDA \bullet k$. Deriving adjustments for the multiple $\frac{P}{E}$ we used the share of returns allocated to dividend payout $D = E \bullet PR$ and then applied it for the classic Gordon model constructed on discounted dividends $V_0 = \frac{D_1}{r-g}$. In the strict sense when deducing the multiple $\frac{P}{E}$ we could have relied upon the Gordon model modification for discounted cash flows for shareholders $V_0 = \frac{FCFE_1}{r-\tilde{g}}$. For this purpose, instead of the share of dividend payout we should have used the $\tilde{k}$ ratio which establishes a relationship between a free cash flow for shareholders and the company profit $FCFE = E \bullet \tilde{k}$. Adjustments for this case are beyond the scope of the present paper, however, we should pay attention to the economic rationale of the k, $\tilde{k}$ and PR indicators. Except for some exclusions (for example, Surgutneftegas) a low PR value implies that a company invests relatively heavily. Low k and $\tilde{k}$ values also mean that the company, other things being equal, invests a lot. The reason is that cash flows turn out to be significantly lower than the *EBITDA* and returns with high capital expenditures. This follows from the formulas:

$$FCFF = EBITDA \bullet (1 - MTR) + D\&A \bullet MTR - \\ - \Delta NWC - CAPEX,$$

$$FCFE = E + D\&A \bullet MTR - \Delta NWC - CAPEX + NB,$$

where $D\&A$ – depreciation, ΔNWC – increment of net working capital, $CAPEX$ – capital expenditures, NB – net borrowing (debt increment).

Some differences may be caused by the fact that k and $\tilde{k}$ decrease if a company builds up working capital on a systematic basis (for example, rapidly growing companies) and changes in the capital structure also impact $\tilde{k}$. Nevertheless, in the long term these indicators are more stable. Thus, the economic rationale of k, $\tilde{k}$ and PR indicators is similar. They show how much a company invests and, consequently, which part of the financial results (measured as *EBITDA* or *E*) the company may allocate consistently among the owners of the share capital or, for k – owners of share and debt capital.

Additionally, we compared accuracy of direct adjustments (type 1, 3, 5, 13, 18 etc.) and adjustments with a reverse multiple in the denominator (type 2, 4, 6, 19 etc.). The obtained estimates lead to the conclusion that adjustments with a reverse multiple diminish differences in multiples by 3–75% more. However, these differences are insignificant.

The considered sample comprises the period of the COVID-19 pandemic and special military operation. To analyze influence of this period for accuracy of adjustments we added fixed time effects while the estimates of the ratios of the adjustment variables remained robust. Ratios of dummy variables of time are presented in Table 6 (2018 is taken as the basic year for valuation).

Table 6. Estimates of fixed time effects

Dependent variable	$\ln(\sigma_{\frac{P}{E}adj})$	$\ln(\sigma_{\frac{EV}{EBITDA}adj})$
2019	0.33 (0.23)	0.61*** (0.21)
2020	1.16*** (0.37)	1.48*** (0.25)
2021	1.18*** (0.27)	1.70*** (0.24)
2022	-0.11 (0.19)	0.96*** (0.19)
2023	0.71*** (0.20)	0.60** (0.29)

Note: *, ** and *** imply the 10%, 5% and 1% significance levels, respectively.

Source: compiled by the authors.

The obtained results indicate that in times of crisis adjustments are useful as well. However, their accuracy is impaired slightly. It is an expected and, probably, inevitable result because in periods of shocks uncertainty regarding the indicators of future performance of the company, which determine the value, increases.

A decrease in the variability of multiples shows that company-specific differences are taken into consideration. However, an improvement of valuation accuracy is an equally important criterion. It is also of importance to determine which valuations are more accurate: those based on the adjusted multiple ($\widehat{P_T} = \theta\left(\frac{P_{B_i}}{E_{B_i}}\right)_{adj} \cdot E_T$ and $\widehat{EV_T} = \theta\left(\frac{EV_{B_i}}{EBITDA_{B_i}}\right)_{adj}$) or those based on unadjusted multiples ($\widehat{P_T} = \theta\left(\frac{P_{B_i}}{E_{B_i}}\right) \cdot E_T$ и $\widehat{EV_T} = \theta\left(\frac{EV_{B_i}}{EBITDA_{B_i}}\right)$).

In the research we calculated deviations of the estimates on the basis of adjusted and unadjusted multiples from actual market stock prices and the company value.

According to the obtained results adjustments entail improvement of the valuation accuracy (Tables 7 and 8). So, if deviation of unadjusted multiples from actual values exceeds 12 net profits and approximately 6 *EBITDA*, the deviation for a series of adjustments amounts to about 0.2–0.3 of net profits and approximately 0.5 *EBITDA* while the multiple values differ from the actual values by 1–3%. This is indicative of the estimates' high accuracy.

Besides, in contrast to the variability of adjusted multiples' values:

- reverse adjustments (in particular, adjustment (1) is more accurate than (2) while adjustment (18) is more accurate than (19)) do not influence accuracy of estimated values);
- when researchers do not take into consideration dividend policy (to equity stock value) and the k parameter related to the ratio of *FCFF* and *EBITDA* (to assess the company value) accuracy increases (in particular, adjustments (2) and (19) when dividend policy and the k parameter are left out provide more accurate estimates than in a case when this parameter is taken into account).

Table 7. Deviations of the obtained estimates from the market stock price

Adjustment	Operator θ returns the average for the sample		Operator θ returns median for the sample	
	$\frac{\lvert\hat{P}-P\rvert}{P}$	$\frac{\hat{P}-P}{E}$	$\frac{\lvert\hat{P}-P\rvert}{P}$	$\frac{\hat{P}-P}{E}$
(1)	1%	0.3	2%	0.2
(2)	29%	-5.7	19%	-5.0
(2) leaving out dividend policy	15%	-2.8	11%	-2.9
(6)	9%	-1.8	7%	-1.7
Without adjustments	66%	12.8	48%	12.6

Source: calculated by the authors.

Table 8. Deviations of the obtained estimates from the market enterprise value

Adjustment	Operator θ returns the average for the sample		Operator θ returns median for the sample	
	$\frac{\lvert\widehat{EV}-EV\rvert}{EV}$	$\frac{\widehat{EV}-EV}{EBITDA}$	$\frac{\lvert\widehat{EV}-EV\rvert}{EV}$	$\frac{\widehat{EV}-EV}{EBITDA}$
(18)	1%	-0.2	3%	-0.5
(19)	21%	-2.6	15%	-2.6
(19) leaving out the ratio of FCFF and EBITDA	4%	0.5	4%	0.7
(25)	49%	-5.7	37%	-6.1
Without adjustments	48%	5.9	38%	6.5

Source: calculated by the authors.

Thus, the hypothesis of elimination of company-specific differences and improvement of valuation accuracy as a part of comparative valuation was confirmed. The hypothesis of different influence of certain adjustments was also confirmed. The hypotheses of improvement of influence of the estimate accuracy, provided the differences in dividend payout and the ratio of *FCFF* and *EBITDA* have been taken into consideration correctly, and also of different accuracy of direct adjustments and adjustments based on the reverse multiple were confirmed partially. If these factors are taken into account individual differences are eliminated and this entails a reduction in variability of adjusted multiples but at the same time in certain cases it results in degradation of accuracy.

Conclusion

In the paper we deduce formulas for adjustments in order to improve accuracy of business valuation on the basis of the analogue company method. The offered valuation allows to take into consideration company-specific differences between the target and comparable companies. This is of particular importance, especially when the number of comparable companies is small or when companies operating abroad prevail among the comparable companies. Adjusted multiples may be calculated by the formulas presented in Table 1 and 2.

The obtained results indicate that adjustments for the cost of capital (expenditures for equity for the *P/E* multiple and *WACC* for the *EV/EBITDA* multiple) are most effective from the point of view of reducing the spread between the multiples of comparable companies. The adjustment for differences in the debt burden diminishes the differences between the *EV/EBITDA* multiples of comparable companies. Growth adjustments result in an increase in the variability of adjusted multiples, and this is due to high error variance in the valuation of anticipated growth rates. Accuracy of valuation of shares and business taking into consideration adjustments for the cost of capital is higher than in case of adjustments both for the cost of calculation and growth. Nevertheless, adjustment for the cost of capital and growth improves accuracy in comparison to the valuation based on unadjusted multiples. The obtained results show that the growth adjustment may be recommended only when it is possible to evaluate accurately the growth rates of the target and comparable companies. If it is impossible, it is reasonable to abandon the growth adjustment or make an adjustment for differences in expected inflation values (for companies from different countries.)

In future studies it is recommended to verify effectiveness of adjustments for the samples of companies from other industries and for other adjustment quality indicators, in particular, for accuracy of the stock price forecast based on adjusted multiples. The authors also believe that there are a lot of promising future research areas: adjustment of the *EV*/revenue multiple, *EV/GMV* multiple, *EV/EBIT* multiple and non-financial multiples. Development of adjustments on the basis of alternatives for the Gordon model, for example, the H-model is also promising.

We made an important conclusion that taking into consideration dividend policy (for the *P/E* multiple) and the ratio of the net cash flow for the firm and *EBITDA* (for the *EV/EBITDA* multiple) is theoretically substantiated and decreases variability of adjusted multiples at the 1–5% significance level (depending on the specification) and accuracy of adjustments relative to the cases when such ratio is not used. Nevertheless, in real practice, taking these factors into consideration did not result in improvement of the valuation accuracy and in certain cases more accurate valuations (in terms of deviation from the actual market stock prices and the company value) were obtained when adjustments left out of account dividend policy and the ratio of *FCFF* and *EBITDA* and reverse multiples were not used. These results may be due to the fact that valuation over long time horizon of dividend policy and the ratio of *FCFF* and *EBITDA* has high error variance. Probably, it is one of the reasons why dividend policy and the ratio of *FCFF* and *EBITDA* are usually not considered by analysts despite their fundamental role in creating the company value.

Multiples' adjustment is a drift towards the discounted cash flows model in value estimation. Adjustments make the multiple method more labour intensive and create risks of degradation of accuracy in valuation in case of errors in determining the values of the factors used for adjustments. Therefore, when adjustments are used for valuation, it is important not just to calculate correctly the values of the factors applied in the adjustments but also rely on professional judgment and contemplate critically the obtained results. Nevertheless, the results of the present research lead us to the conclusion that correct use of adjustments provides an opportunity to improve accuracy of the estimate based on formal theoretically substantiated valuation.

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85. Appendix

Table 9. Descriptive statistics of variables

	Minimum	Median	Maximum	Average	Standard deviation
P/E	0.7	19.5	219	26.2	26.7
EV/EBITDA	0.2	12.4	503	17.2	35.7
$\ln(\sigma_{\frac{P}{E}adj})$	-0.17	3.36	8.90	3.46	1.73
$\ln(\sigma_{\frac{EV}{EBITDA}adj})$	0.06	2.61	8.40	2.74	1.65
Inflation for all countries	0.0	0.02	0.08	0.03	0.02
Inflation in the USA	0.03	0.04	0.07	0.04	0.01
Inflation in Russia	0.03	0.07	0.12	0.07	0.03
Expected blended growth rate of profit	-0.18	0.03	0.13	0.03	0.05
Expected blended growth rate of EBITDA	-0.28	0.03	0.25	0.03	0.10
Risk-free rate for all countries	0.01	0.02	0.13	0.03	0.03
Risk-free rate in the USA	0.00	0.02	0.05	0.02	0.02
Risk-free rate in Russia	0.05	0.07	0.11	0.08	0.07
Market risk premium	0.04	0.06	0.11	0.06	0.01
Beta	0.54	1.00	2.40	1.13	0.37
Debt burden	0.00	0.33	5.58	0.62	0.68
Income tax rate	0.15	0.25	0.34	0.26	0.04
Return on equity	-0.07	0.10	0.49	0.12	0.09

Source: compiled by the authors on the basis of calculations.

Table 10. Correlation matrix of variables

	$\ln(\frac{P}{E}_{adj})$	$\ln(\sigma_{\frac{EV}{EBITDA}_{adj}})$	Risk-free rate in the USA	Risk-free rate in Russia	Inflation in the USA	Inflation in Russia
$\ln(\sigma_{\frac{P}{E}_{adj}})$	1	0.71	-0.22	0.08	-0.09	-0.20
$\ln(\sigma_{\frac{EV}{EBITDA}_{adj}})$	0.71	1	-0.11	0.59	-0.21	-0.16
Risk-free rate in the USA	-0.22	-0.11	1	0.41	0.13	0.22
Risk-free rate in Russia	0.08	0.59	0.41	1	-0.05	0.12
Inflation in the USA	-0.09	-0.21	0.13	-0.05	1	0.64
Inflation in Russia	-0.20	-0.16	0.22	0.12	0.64	1

Source: calculated by the authors.

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