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Capital Asset Pricing Model (CAPM) 2.0: Account of Business and Financial Risk

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ABSTRACT

The famous Capital Asset Pricing Model (CAPM), widely used in practice, takes into account only the business risk associated with investments in a specific company [not the entire market (or industry)]. In practice, most listing companies use debt financing and operate at a non-zero leverage level. This means that the financial risk associated with the use of debt financing, along with business risk, must be taken into account. The **purpose** of this paper is to simultaneously account for business and financial risk. We combined the CAPM theory and the Modigliani-Miller (MM) theory, which is the perpetual limit of the BFO (Brusov-Filatova-Orekhova) theory. The article shows that R. Hamada's attempt to take into account both business and financial risks has proved unsustainable, and the formulas he obtained, widely used in practice, are incorrect. The paper outlines the correct formulae that made it possible to generalize CAPM for the first time, taking into account both business and financial risk. The application of the new CAPM 2.0 model to a number of companies is considered and the difference between the results obtained within the framework of CAPM 2.0 and CAPM is demonstrated. CAPM is one of the main models [along with APT (arbitrage pricing theory) and WACC] within the income approach to business valuation. This significantly increases the value of the developed CAPM 2.0 approach, which can significantly improve the accuracy of the assessment.

Keywords: business and financial risks; capital structure; Modigliani-Miller (MM) theory; Brusov-Filatova-Orekhova (BFO) theory; risk and profitability; CAPM; Fama-French model; business valuation

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INTRODUCTION

Based on the portfolio theory by Harry Markowitz, the Capital Asset Pricing Model (CAPM) was developed independently [1–5] by Jack Traynor (1961), F. William Sharp (1964), John Lintner (1965) and Jan Mossin (1966). Subsequently, this model was improved and developed in works [6–16].

The Capital Asset Pricing Model (CAPM) takes into account only business risk. In practice, companies use debt financing and operate at non-zero levels of leverage. This means that it is necessary to take into account the financial risk associated with the use of debt financing, along with the business risk. The purpose of this paper is to simultaneously take into account business and financial risk. A new approach to CAPM has been developed that takes into account both business and financial risk. We combine the theory of CAPM and the Modigliani-Miller (MM) theory [17–22]. The first is based on portfolio analysis and accounting for business risks in relation to the market (or industry). The second one (the Modigliani-Miller (MM) theory [17–22]) describes a specific company and takes into account the financial risks associated with the use of debt financing. The combination of these two different approaches makes it possible to take into account both types of risks: business and financial ones. We combined these two approaches analytically, while R. Hamada [15, 16] did it phenomenologically. Using the Modigliani-Miller (MM) theory [17–22], it is shown that the Hamada model, the first model used for this purpose half a century ago, is incorrect. In addition to the renormalization of the beta–coefficient, obtained in the Hamada model [15, 16], two additional terms are found: the renormalized risk–free return and the term dependent on the cost of debt kd. A critical analysis of the Hamada model was carried out. The vast majority of listing companies use debt financing and are levered, and Hamada's model [15, 16], due to its inaccuracy, is not applicable to them, in contrast to the new approach applicable to companies with debt capital. Implemented a new approach for specific companies. A comparison of the results of the new approach with the results of the conventional CAPM is shown. Two versions of CAPM (market or industry) are considered.

In the real economy, financial and business risks exist. Financial risks are related to the use of debt financing and are described by capital structure theories: BFO theory and its perpetual limit — MM theory. Business risks are associated with investments in a specific company [and not in the entire market (or industry)] and are described by CAPM (market or industry version).

CAPM (CAPITAL ASSET PRICING MODEL)

Market approach

CAPM is a simple, but widely used, one–factor model that describes the relationship between the expected return on assets (stocks, investments, etc.) and the risk–free rate, taking into account systematic (business) risk. This relationship is described by the equity risk premium, which depends on the asset's beta (which describes the asset's correlation or sensitivity to the market), the risk–free rate (say, the Treasury bill rate or the central bank's key rate), and the expected return in the market. CAPM assumes an idealized open market structure where all risky assets refer to all tradable shares available to everyone. In addition, we have a risk–free asset (for borrowing and/or lending in unlimited quantities) with an interest rate of k_f. One assumes that all information is available to everyone, such as covariances, variances, average stock returns and so on. One also assumes that an investor is rational, risk–averse, and uses the same Markowitz portfolio theory.

The following abbreviations are used below:

CAPM: Capital Asset Pricing Model

MM: the Modigliani-Miller theory;

$k_i; k_I; k_m$ stand for company, industry and market expected yield values;

$\sigma_i; \sigma_I; \sigma_m$ are standard deviations for company, industry and market returns;

$\beta_{iI}; \beta_{im}$ are beta coefficients company to industry and to market;

L — leverage level; k_d — the cost of debt.

The following assumptions are made within the CAPM model:

1) All investors are risk averse and have the same time frame to evaluate information.

2) Unlimited capital exists to borrow at the risk-free rate.

3) Investments can be divided into unlimited parts and sizes.

4) Taxes, inflation and transaction costs are absent.

5) Return and risk are linearly related.

CAPM (Capital Asset Pricing Model) describes the profitability of assets and is described by the following formula:

$$k_i = k_f + \beta_i \left(k_m - k_f\right). \quad (1)$$

Here, k_f is risk free profitability, β is the β-coefficient of the company. It shows the dependence of the return on the asset and the return on the market as a whole. The β-coefficient is described by the following formula:

$$\beta_i = \frac{\text{cov}_{im}}{\sigma_m^2} = \rho_{im} \frac{\sigma_i}{\sigma_m}. \quad (2)$$

Here σ_i is the risk (standard deviation) of *i*-th asset, σ_m is market risk (standard deviation of the market index), cov_{im} is covariance between *i*-th asset and market portfolio.

An investor invests in risky securities only if their return is higher than the return on risk-free securities, so always $k_i > k_f$ and $k_m > k_f$.

The beta-coefficient of a security, β, has the meaning of the amount of riskiness of this security. It follows from formula (1) that:

1) if β = 1 the yield of the security is equal to the yield of the average market portfolio ($k_i = k_f$);

2) if β > 1, the security is more risky than the average on the security market

$$(k_i > k_f);$$

3) if β < 1, the security is less risky than the average on the security market

$$(k_i < k_f).$$

Securities betas are calculated using statistical data on returns on specific securities and the average market returns on securities traded on the market.

Disadvantages of the CAPM model

CAPM has some well-known disadvantages.

1. The CAPM formula only works under assumption that the market is dominated by purely rational players who make decisions that favor only investment returns.

This, of course, is not always true.

2. CAPM assumes that each market participant acts on the basis of the same information. In reality, relevant information is distributed unevenly among the public, so some participants may make decisions based on information that others do not.

3. Using beta as the main part of the formula. But beta takes into account only changes in the stock price in the market. However, the share price can change for reasons other than the market. Stocks can rise or fall in value for deliberate reasons, not just volatility.

4. CAPM only uses historical data. But historical stock price changes are not enough to determine the overall risk of an investment. Other factors should be considered, such as economic conditions, industry peculiarities and competitor characteristics, and internal and external activities of the company itself.

So, the model has a number of limitations: it does not take into account taxes, transaction costs, non–transparency of the financial market, etc.

Finally, to predict future returns, a retrospective level of market risk is used, which leads to a forecast error.

Modifications of CAPM: The multiple factors models

The CAPM operates on only one factor that affects the future performance of a stock.

There are several models with multiple factors that modify the CAPM in this regard. Among them are Fama–French (three– and five– factor models) and APT (Arbitrage Pricing Theory) models [23].

Fama-French model

In 1992, Y. Fama K. and French [6–9] proved that future returns are also affected by factors such as company size and industry affiliation. They have developed three– and five– factor models.

Fama-French Three-factor Model

The Fama-French three-factor model takes into account two additional risk factors, namely, size and book to market equity, along with market beta:

$$k_e = k_f + \beta_U \left(k_m - k_f\right) + s \cdot SMB + h \cdot HML\,,$$

were *SMB* — the difference between the returns of companies with large and small capitalizations;

HML — the difference between the returns of companies with low and high intrinsic value (*indicator B/P*).

Fama-French Five-factor Model

$$k_e = k_f + \beta_U \left(k_m - k_f\right) + s \cdot SMB + \\ + h \cdot HML + r \cdot RMW + c \cdot CMA,$$

where *RMW* — return on equity; *CMA* — company capital expenditure.

Arbitrage Pricing Theory (APT)

In the APT model [23], the return on an asset can be expressed by the following formula:

$$r_i = a_i + \beta_{i1} F_1 + \beta_{i2} F_2 + \ldots + \beta_{in} F_n + \varepsilon_i\,,$$

where a_i is a constant per asset; F_i is a systematic factor, such as a macroeconomic or company — specific factor; β_i is the sensitivity of the asset in relation to the factor F_i; and ε_i is a random variable with an expected mean of zero.

APT formula has the form:

$$E(r_i) = r_f + \beta_{i1} \widehat{F}_1 + \beta_{i2} \widehat{F}_2 + \ldots + \beta_{in} \widehat{F}_n\,,$$

where r_f is the risk-free rate of return, β_{ik} is the sensitivity of the asset *i* with respect to factor k, $\widehat{F}_k$ is the risk premium for factor k.

In contrast to the CAPM, which has only one factor and one beta, the APT formula has multiple factors that include non–company factors, which requires the asset's beta with respect to each separate factor. The APT does not explain what these factors are, and APT model users should analytically determine factors that might affect the asset's returns. The factor used in the CAPM is the difference between the market rate of return and the risk-free rate of return.

The CAPM is a one-factor model and is simpler to use. Thus, investors prefer to use it to evaluate the expected rate of return rather than using the APT, which requires users to evaluate multiple factors.

Industry Approach

CAPM has an alternative approach that refers to the industrial index rather than the market.

$$k_i = k_f + \beta_i \left(k_I - k_f\right). \qquad (3)$$

Here, k_f is risk free profitability, β is the β-coefficient of the company. In this case it shows the dependence of the return on the asset and the return on the industry as a whole. The β-coefficient is now described by the following formula:

$$\beta_i = \frac{\mathrm{cov}_{iI}}{\sigma_I^2} = \rho_{iI}\frac{\sigma_i}{\sigma_I}. \quad (4)$$

Here σ_i — the risk of *i*-th asset, σ_I — industry risk (standard deviation of industry index), cov_{iI} — covariance between *i*-th asset and industry index. Note, that the industry approach better describes the return on an asset than the market approach.

The CAPM approach is still evolving and we will describe one of the directions of this development below.

The Symmetric CAPM

One of the remaining internal problems of CAPM is the distribution function. The capital asset pricing model (CAPM) is often based on the Gaussianity or normality assumption. However, such an assumption is frequently violated in practical situations. In [10], a symmetric CAPM is proposed, assuming distributions with lighter or heavier tails than the normal distribution. Elliptic distributions (normal, exponential and Student-t) are considered. This consideration is of a general nature. The authors conducted a detailed case study to apply the obtained results, estimating the systematic risk of the financial assets of a Chilean company with real data. A Chilean company is just an illustration of the results obtained.

In addition, the authors of [10] study the methods of leverage and local impact for diagnostics in a symmetric CAPM. It is concluded that the considered models give better results than the CAPM with a Gaussian distribution.

In [11–13], empirical studies were carried out under the assumption that stock returns have distributions with heavier tails than the normal distribution.

The student-t distribution instead of the normal distribution was considered in [12] and [14], taking into account the maximum likelihood method for estimating its parameters. The paper [13] concluded that asset valuation should be carried out within the framework of the CAPM and the discounted dividend model.

HAMADA MODEL

The Modigliani-Miller theory [17–25], with the accounting of taxes, was united with CAPM (capital asset pricing model) in 1961 by Hamada [15, 16]. For the cost of equity of a leveraged company, the below formula has been derived.

$$k_e = k_f + \beta_U\left(k_m - k_f\right) + \beta_U\left(k_m - k_f\right)\frac{D}{S}(1-t). \quad (5)$$

The first term represents risk-free profitability k_f, the second term is business risk premium, $\beta_U\left(k_m - k_f\right)$, and the third term is financial risk premium $\beta_U\left(k_m - k_f\right)\frac{D}{S}(1-t)$.

In the case of an unlevered company ($D = 0$), the financial risk (the third term) is zero, and its shareholders receive only a business risk premium.

Hamada used an empirical approach to incorporating the level of leverage into the CAPM. One of the main objectives of his research was to distinguish companies without leverage from those with leverage. The latter make up almost the majority of real companies. In 1972, he surveyed 304 companies, among which he found 102 non-leveraged and 202 leveraged [16]. Comparing the equity returns of two types of companies, he got his formula for the β-factor, which takes into account the level of leverage.

The incorrectness of the Hamada approximation will be shown below in the framework of the new approach we have developed, which describes both business and financial risk.

CAPM 2.0

In this section, we develop a new approach that describes both business and financial risk. We call this approach CAPM 2.0. as opposed to conventional CAPM, which accounts only for business risk.

Derivation of the Main Formula CAPM 2.0

Let's combine CAPM (capital asset pricing model) and the Modigliani-Miller theory [17–24] not phenomenologically, like Hamada [15, 16], but analytically and let's do it right.

Substituting the CAPM formula [23–25]

$$k_0 = k_f + \beta_U\left(k_m - k_f\right) \quad (6)$$

into Modigliani-Miller formula for equity cost

$$k_e = k_0 + L\left(k_0 - k_d\right)(1-t), \quad (7)$$

one gets the following result

$$
\begin{aligned}
k_e &= k_0 + L(k_0 - k_d)(1-t) = \\
&= k_f + \beta_U(k_m - k_f) + L(k_f + \beta_U(k_m - k_f) - k_d)(1-t) = \\
&= k_f(1 + L(1-t)) + \beta_U(k_m - k_f)(1 + L(1-t)) - Lk_d(1-t)
\end{aligned} \quad (8)
$$

The second term is the same as in Hamada's formula (3), but the first term is renormalized value of risk-free profitability and the last term, which depends on the cost of debt kd, is missing from Hamada's formula (3).

So, the difference with Hamada's formula is: while in Hamada's formula only beta coefficient β is renormalized, in formula (8) the first term (risk-free return) is also renormalized by the same factor $(1 + L(1-t))$ and the last term, depending on the cost of debt kd, appears, which is absent in Hamada's formula. Factor $(1-t)$ (tax corrector) exists due to the tax shield.

The incorrectness of Hamada's approximation becomes obvious.

We could rewrite expression (8) as a sum of two parts, one of which is the Hamada expression, and the second is an additional term that we received:

$$
\begin{aligned}
k_e &= k_f + \beta_U(k_m - k_f)(1 + L(1-t)) + k_f L(1-t) - Lk_d(1-t) = \\
&= k_f + \beta \cdot (k_m - k_f) + L(1-t)(k_f - k_d) = k_{e;CAPM} + \Delta
\end{aligned} \quad (9)
$$

Here

$$\Delta = L(1-t)(k_f - k_d). \quad (10)$$

The formula (9) takes into account both business and financial risk and is the main result of the work. Below, in Section 4, we will apply developed by us approach CAPM 2.0 to several companies, calculate their profitability using formula (9) and compare the obtained results with conventional CAPM that take only business risks into account (with some notes).

From the formula (10) it follows, that the value added to the company's return (Δ) with respect to results of conventional CAPM does not depend on the industry or market version of CAPM and turns out to be the same for both cases.

This term (10) disappears ONLY if $k_f = k_d$, but as we will see below for several companies, this never happened. **This means that the Hamada model is never correct and the CAPM 2.0 model, which properly considers financial risk alongside business risk, should be used.**

As we will see below, the sign of the term (10), as well as its contribution to profitability, depend on the relationship between k_f and k_d: it increases profitability, if $k_f > k_d$ and decreases it if $k_f < k_d$.

Another piece of indirect evidence that Hamada's model is wrong is that it accounts for debt financing but does not use the cost of debt k_d (which appears naturally in our CAPM 2.0 model).

METHODOLOGY AND FEATURES OF THE APPLICATION OF THE NEW APPROACH

It is clear that the vast majority of companies are leveraged because they use debt financing. The use of debt financing is determined by several factors.

1. All listing companies are quite large and participate in expanded reproduction, which requires the attraction of borrowed capital.

2. The use of debt financing allows you to take advantage of the tax shield: by reducing the cost of capital raised and increasing the company's value.

This means that the standard CAPM formula takes into account business risk and part of the financial risk accounted for by the leveraged beta coefficient in the form of Hamada. This reduces the importance of Hamada's formula, since the covariance found from the statistical reporting and beta-coefficient already contains the level of leverage and does not need to be renormalized. While the additional term(s) found by us must be taken into account in order to correctly determine the premium for financial risk.

If we consider the almost never occurring case of a non-leveraged company, then we need to apply the standard CAPM formula with a non-leveraged beta. However, if we want to make a forecast for assessing the profitability of the company, taking into account the future level of leverage, it is necessary to take into account all three of the above additives related to taking into account debt financing.

Application of developed by us approach to several companies

The application of the new approach is carried out through the following steps:

• **At the first stage**, it is necessary to collect and process statistical data at three levels: company, industry and market.

We need the following parameters:

1) For company $k_i; L, k_d; \sigma_i; \beta_{iI}; \beta_{im}$;

2) For industry $k_I; L, k_d; \sigma_I; \beta_{iI}$;

3) Market $k_m; \sigma_m; \beta_{im}$

Here $k_i; k_I; k_m$ stand for company, industry and market expected yield values;

$\sigma_i; \sigma_I; \sigma_m$ are standard deviation for company, industry and market returns;

$\beta_{iI}; \beta_{im}$ are beta coefficient company to industry and to market;

L — leverage level; k_d — the cost of debt.

It is also necessary to use methods for their processing, since we will operate with average annual values, and the data on the sites usually gives daily quotes.

- **At the second stage,** we evaluate the company's profitability within the traditional CAPM.
- **At the third stage,** one needs to use formulas (9) and (10) to estimate the company return taking into account both business and financial risk.
- **At the fourth stage**, the company's profitability is compared on the traditional CAPM approach and the new CAPM 2.0 approach.

We have a database of dozens of companies from different countries, that can be accessed upon request. Five companies (PJSC Severstal, PJSC Polymetal, PJSC Rosneft, Pfizer INC., Walt Disney Company) were selected to illustrate the results obtained. As will be seen below, the results of the five selected companies, as well as other companies, are highly dependent on the level of leverage and the difference between k_d and k_F. Below, we present and compare the results of a sample of five companies within the traditional CAPM approach and within the new CAPM 2.0 approach (*Table 1*).

Estimation of the Return of PJSC Severstal for the Period 2018–2021 by CAPM (Ticker PJSC Severstal on the Moscow Exchange is CHMF)

In *Table 2* comparison of PJSC Severstal profitability estimates for the period 2018–2021 on CAPM and on the new CAPM 2.0 approach is shown.

From the *Tables 1, 2* it follows that that accounting for financial risk properly significantly affects the assessment of the return on assets in both versions of CAPM: industry and market.

In industry CAPM/ CAPM 2.0 return in 2018 was **8.29%**/12.43%;

in 2019 **6.99%**/12.04%;

in 2020 **44.22%**/47.71%;

in 2021 **7.38%**/11.76%.

In market CAPM/ CAPM 2.0 return in 2018 was **11.22%**/15.36%;

in 2019–**7.64%**/–2.61%;

in 2020 **7.51%**/11.0%;

in 2021 **13.93%**/18.29%.

It can be seen that the financial risk premium increases the company's income each year. This happened because, as can be seen from the data (*Table 1*), the risk-free return exceeds the credit rate $k_f > k_d$.

Estimation of the Return of PJSC Polymetal for the Period 2018–2022 by CAPM Capital Asset Pricing Model (Ticker PJSC Polymetal on the Moscow Exchange is POLY)

Summary of indicators for Polymetal shares, the RTS mining and metal index and the MICEX index in the period 2018–2022 could be found in *Table 3*.

Table 3 gives: (1) the company's average annual return; (2) the company's profitability with an industry business risk premium; (3) profitability of a company with a market business risk premium.

Results for PJSC Polymetal profitability for the period 2018–2022 on CAPM and on the new CAPM 2.0 approach are presented in *Table 4*.

From the *Tables 3, 4* it follows that that accounting for financial risk properly significantly affects the assessment of the return on assets in both versions of CAPM: industry and market.

In industry CAPM/ CAPM 2.0 return in 2018 was 2.11%/19.32%;

in 2019 40.20%/47.57%;

in 2020 56.08%/58.93%;

in 2021 12.37%/14.30%;

in 2022–9.80%/–1.36%.

In market CAPM/ CAPM 2.0 return in 2018 was 12.51%/29.72%;

in 2019 12.99%/20.36%;

in 2020 14.67%/17.52%;

in 2021 6.09%/8.02%;

in 2022–3.68%/4.76%.

It can be seen that the financial risk premium increases the company's income each year. This happened because, as can be seen from the data (*Table 3*), the risk-free return exceeds the credit rate $k_f > k_d$.

Table 1

Estimation of Indicators and of the Return of PJSC Severstal for the Period 2018–2021 by CAPM

Level	Indicators	2018	2019	2020	2021
k_F		8.02%	7.59%	6.27%	7.34%
Company CHMF	k_i	6.23%	–0.53%	41.01%	21.27%
	L	1.21	1.75	1.51	1.37
	k_d	3.77%	3.98%	3.38%	3.36%
	σ_i	0.24	0.19	0.26	0.28
Industry	k_I	8.71%	10.68%	47.75%	7.37%
	L	0.41	0.81	0.66	0.68
	σ_I	0.19	0.11	0.24	0.17
	$\beta_{i.I}$	0.40	–0.19	0.91	1.42
Market IMOEX	μ_m	12.20%	28.58%	8.06%	15.08%
	σ_m	0.17	0.11	0.26	0.16
	$\beta_{i.m}$	0.77	–0.73	0.69	0.85
k_i		**6.23%**	**–0.53%**	**41.01%**	**21.27%**
k_i CAPM (Industry)		**8.29%**	**6.99%**	**44.22%**	**7.38%**
k_i CAPM (market)		**11.22%**	**–7.64%**	**7.51%**	**13.93%**

Source: Compiled by the authors.

Table 2

Comparison of PJSC Severstal Profitability Estimates for the Period 2018–2021 on CAPM and on the New CAPM 2.0 Approach

Variables	2018	2019	2020	2021
k_i	**6.23%**	**–0.53%**	**41.01%**	**21.27%**
k_i **CAPM (industry)**	**8.29%**	**6.99%**	**44.22%**	**7.38%**
k_i **CAPM (market)**	**11.22%**	**–7.64%**	**7.51%**	**13.93%**
Δ	4.14%	5.05%	3.49%	4.36%
k_i **CAPM (industry)** New approach	12.43%	12.04%	47.71%	11.76%
k_i **CAPM (market)** New approach	15.36%	–2.61%	11.0%	18.29%

Source: Compiled by the authors.

Table 3

Summary Table of Indicators for Polymetal Shares, the RTS Mining and Metal Index and the MICEX Index in the Period 2018–2022

Year	2018	2019	2020	2021	2022
Company level (Polymetal)					
Profitability actual	3.48%	32.80%	78.71%	–24.39%	–71.71%
Standard deviation	0.304	0.242	0.454	0.264	0.705
Average debt cost	3.52%	4.89%	4.00%	2.88%	3.28%
Leverage level	4.78	3.41	1.57	0.54	1.6
Industry level (RTS mining and metal index)					
Profitability actual	2.11%	40.20%	56.08%	12.37%	–9.80%
Standard deviation	0.233	0.144	0.390	0.230	0.580
Average leverage level	0.408	0.370	0.351	1.128	0.818
Beta with Polymetal	0.208	0.107	0.436	0.349	0.250
Profitability (industry CAPM)	6.79%	11.07%	27.97%	9.10%	4.96%
Correlation with Polymetal	0.27	0.18	0.51	0.40	0.30
Market level (Moscow Exchange index MICEX)					
Profitability actual	18.15%	36.24%	22.57%	3.25%	–16.78%
Standard deviation	0.167	0.120	0.271	0.163	0.497
Beta with Poly	0.443	0.189	0.516	0.307	0.508
Profitability (market CAPM)	12.51%	12.99%	14.67%	6.09%	–3.68%
Correlation with Polymetal	0.24	0.09	0.31	0.19	0.36
k_F	8.02%	7.59%	6.27%	7.34%	9.87%

Source: Compiled by the authors.

Table 4

Comparison of PJSC Polymetal Profitability Estimates for the Period 2018–2022 on CAPM and on the New CAPM 2.0 Approach

Year	2018	2019	2020	2021	2022
Profitability actual	3.48%	32.80%	78.71%	–24.39%	–71.71%
Profitability (industry CAPM)	2.11%	40.20%	56.08%	12.37%	–9.80%
Profitability (market CAPM)	12.51%	12.99%	14.67%	6.09%	–3.68%
Δ	17.21%	7.37%	2.85%	1.93%	8.44%
Profitability (industry CAPM) New approach	19.32%	47.57%	58.93%	14.30%	–1.36%
Profitability (market CAPM) New approach	29.72%	20.36%	17.52%	8.02%	4.76%

Source: Compiled by the authors.

Table 5

Summary Table of Indicators for PJSC Rosneft, ROSN Shares, Industry an Market Indexes in the Period 2018–2021

Level	Index	2018	2019	2020	2021
Company	k_i	53.3%	7.2%	4.4%	42.0%
	σ_i	0.255561	0.173661	0.424433	0.256377
	L_i	5.1	4.4	5.1	4.8
	kd	1.55%	0.86%	2.73%	2.34%
Industry	k_I	36%	24%	–16%	25%
	σ_I	0.164794	0.130976	0.318362	0.194733
	L_I	0.415428	0.361656	0.359434	1.135839
	β_{iI}	0.690794	0.817217	1.19458	0.964128
Market	μ_m	12%	29%	8%	15%
	σ_m	0.171552	0.111067	0.259559	0.163953
	β_{im}	0.450119	0.829661	1.382028	0.987169
	k_i ,%	53.3%	7.2%	4.4%	42.0%
	k_i , Industry %	27.4%	21.4%	–20.3%	24.1%
	k_i , Market %	9.93%	24.96%	8.66%	15.05%

Source: Compiled by the authors.

Table 6

Comparison of PJSC Rosneft, ROSN Profitability Estimates for the Period 2018–2021 on CAPM and on the New CAPM 2.0 Approach

Year	2018	2019	2020	2021
k_F	8.02%	7.59%	6.27%	7.34%
Δ	26.40%	23.69%	14.44%	19.20%
k_i, %	53.3%	7.2%	4.4%	42.0%
k_i, Industry, %	27.4%	21.4%	–20.3%	24.1%
k_i, Market, %	9.93%	24.96%	8.66%	15.05%
k_i CAPM (Industry) New approach	53.8%	45.09%	–5.86%	43.3%
k_i CAPM (market) New approach	36.33%	48.65%	23.10%	34.25%

Source: Compiled by the authors.

Table 7

Summary Table of Indicators for Pfizer INC., PFE Shares, Industry a Market Indexes in the Period 2018–2022

Level	Index	2018	2019	2020	2021	2022
Company	k_i	17.86%	–7.70%	4.28%	64.48%	2.83%
	σ_i	0.047	0.050	0.10	0.08	0.072
	L_i	1.5	1.64	1.43	1.34	1.06
	k_d	3.26%	3.54%	3.36%	3.57%	3.67%
	β_{im}	0.92	0.298	0.87	0.38	0.51
	ρ_{im}	0.78	0.20	0.63	0.15	0.47
Industry	k_I	–1.76%	13.39%	14.74%	22.60%	– 3.47%
	σ_I	0.05	0.03	0.056	0.04	0.045
	L_I	1.55	1.63	1.72	1.77	1.59
	k_d	4.56%	3.67%	3.00%	3.58%	5.88%
	β_{iI}	0.87	1.03	1.53	0.53	1.16
	ρ_{iI}	0.92	0.64	0.83	0.26	0.71
Market	k_m	– 11.22%	19.48%	16.45%	28.32%	17.61%
	σ_m	0.04	0.033	0.075	0.030	0.066
	β_{im}	0.92	0.298	0.87	0.38	0.51
k_F		3.02%	2.39%	1.00%	1. 91%	3.98%
k_i (Industry)		–1.13%	13.73%	21.98%	12.91%	– 4.64%
k_i (Market)		– 10. 04%	7.49%	14.44%	12.05%	10.98%

Source: Compiled by the authors.

Table 8

Comparison of Pfizer INC., PFE Shares Profitability Estimates for the Period 2018–2022 on CAPM and on the New CAPM 2.0 Approach

Year	2018	2019	2020	2021	2022
k_F	3.02%	2.39%	1.00%	1.91%	3.98%
Δ	–0.29%	–1.49%	–2.67%	–1.76%	0.26%
k_i	17.86%	–7.70%	4.28%	64.48%	2.83%
k_i (Industry)	–1.13%	13.73%	21.98%	12.91%	–4.64%
k_i (Market)	–10.04%	7.49%	14.44%	12.05%	10.98%
k_i **CAPM (Industry)** New approach	–1.42%	12.24%	19.31%	11.1%	–4.38%
k_i **CAPM (market)** New approach	–10.33%	6.05%	11.77%	10.29%	11.24%

Source: Compiled by the authors.

Estimation of the Return of PJSC Rosneft, ROSN for the Period 2018–2021 by CAPM

Summary of indicators for PJSC Rosneft, ROSN shares, industry and market indexes in the period 2018–2021 could be found in *Table 5.*

It can be seen that the financial risk premium increases the company's income each year. This happened because, as can be seen from the data (*Table 6*), the risk-free return exceeds the credit rate $k_f > k_d$.

Estimation of the Return of Pfizer INC., PFE for the Period 2018–2022 by CAPM

Summary of indicators for Pfizer INC., PFE shares, industry a market indexes in the period 2018–2022 could be found in *Table 7.*

It can be seen that the financial risk premium decreases the company's income in 2018–2021. This happened because, as can be seen from the data (*Table 8*), the credit rate exceeds the risk-free return $k_f < k_d$. The financial risk premium increases the company's income in 2022. This takes place because, as can be seen from the data (*Table 8*), the risk-free return exceeds the credit rate $k_f > k_d$.

Estimation of the Return of Walt Disney Company: DIS for the Period 2018–2022 by CAPM

A summary of indicators for Walt Disney Company: DIS shares, industry a market indexes in the period 2018–2022 could be found in *Table 9.*

It can be seen that the financial risk premium decreases the company's income in 2018–2021. This happened because, as can be seen from the data (*Table 9*), the credit rate exceeds the risk-free return $k_f < k_d$. The financial risk premium increases the company's income in 2022. This takes place because, as can be seen from the data (*Table 9*), the risk-free return exceeds the credit rate $k_f > k_d$.

From *Tables 5–10,* it follows that when k_d exceeds k_F, the financial risk premium becomes negative. It can also be seen in *Tables 1–6* that for companies from the extractive industries, such as Rosneft, Polymetal, and to a lesser extent Severstal, whose leverage level, due to the specifics of the industry is quite high, the premium for financial risk is high as well.

At the same time, companies with a typical level of leverage from 0.5 to 1 (1.5) have a low financial risk premium compared to business risk (see *Tables 7–10*). This is well seen for Walt Disney Company (L is of order 0.5) and for Pfizer INC. (L is of order 1–1.5)

CONCLUSIONS

A new approach has been developed to a return on assets assessment that generalizes CAPM to account for both business and financial risks. We combined the CAPM theory and the Modigliani-Miller (MM) theory, which is the perpetual limit of the BFO (Brusov-Filatova-Orekhova) theory. The first is based on portfolio analysis and accounting for

Table 9

Summary Table of Indicators for Walt Disney Company: DIS Shares, Industry (SPLRCD) and Market (S&P500) Indexes in the Period 2018–2022

Level	Index	2018	2019	2020	2021	2022
Company	k_i	1.99%	31.90%	25.27%	–14.51%	–43.91%
	σ_i	0.041	0.088	0.132	0.069	0.108
	L_i	0.43	0.53	0.70	0.61	0.51
	k_d	3.27%	2.65%	2.81%	2.84%	3.20%
	$\hat{a}_{im}$	0.57	0.93	1.54	1.23	1.18
Industry (SPLRCD)	k_I	–0.49%	26.20%	32.07%	23.66%	–37.58%
	σ_I	0.057	0.046	0.090	0.041	0.089
	L_I	0.20	0.20	0.15	0.15	0.33
	$\hat{a}_{iI}$	0.355	0.695	1.081	0.049	0.816
	k_i	1.78%	18.94%	34.55%	2.96%	–29.94%
Market (S&P500)	k_m	–6.24%	28.88%	16.26%	26.89%	–19.44%
	σ_m	0.044	0.037	0.075	0.032	0.066
	$\hat{a}_{im}$	0.57	0.93	1.54	1.23	1.18
	k_F	3.020%	2.389%	1.646%	1.905%	3.975%
	k_i	–2.28%	27.13%	24.14%	32.61%	–23.64%
	k_i, Company	1.99%	31.90%	25.27%	–14.51%	–43.91%
	k_i, Industry	1.78%	18.94%	34.55%	2.96%	–29.94%
	k_i, Market	–2.28%	27.13%	24.14%	32.61%	–23.64%

Source: Compiled by the authors.

business risks in relation to the market (or industry). The second one (the Modigliani-Miller (MM) theory) describes a specific company and takes into account the financial risks associated with the use of debt financing. The combination of these two different approaches makes it possible to take into account both types of risks: business and financial ones. We combined these two approaches analytically, while Hamada did it phenomenologically. Both approaches are quite well developed and tested, so the validity of the model built on these two approaches is beyond doubt. It is shown that in addition to the renormalization of the beta-coefficient obtained in the Hamada model, two additional terms are found: the renormalized risk-free income and the term depending on the cost of debt kd. A critical analysis of the Hamada model was carried out, which showed that the Hamada model is not applicable in practice. The additional term (10), obtained by us, disappears ONLY if $k_f = k_d$, but as we will see above for several companies, this never happened. **This means that the Hamada model is never correct and the CAPM 2.0 model, which takes into account financial risk along with business risk, should be used.** As we have seen above, the sign of the term (10), as well as its contribution to profitability,

Table 10

Comparison of Walt Disney Company: DIS Shares Profitability Estimates for the Period 2018–2022 on CAPM and on the New CAPM 2.0 Approach

Year	2018	2019	2020	2021	2022
k_F	3.02%	2.39%	1.646%	1.91%	3.98%
Δ	–0.08%	–0.11%	–0.64%	–0.45%	0.31%
k_i, Company	1.99%	31.90%	25.27%	–14.51%	–43.91%
k_i, Industry	1.78%	18.94%	34.55%	2.96%	–29.94%
k_i, Market	–2.28%	27.13%	24.14%	32.61%	–23.64%
k_i CAPM (Industry) New approach	1.70%	18.83%	33.91%	2.51%	–29.63%
k_i CAPM (market) New approach	–2.36%	27.02%	23.50%	32.16%	–23.33%

Source: Compiled by the authors.

depend on the relationship between k_f **and** k_d **:** it increases profitability, if $k_f > k_d$ and decreases it if $k_f < k_d$.

Another piece of indirect evidence that Hamada's model is wrong is that it accounts for debt financing but does not use the cost of debt k_d (which appears naturally in our CAPM 2.0 model).

Two versions of CAPM (market or industry) are considered. It has been shown, that the value added to the company's return (Δ) with respect to the results of conventional CAPM does not depend on the industry or market version of CAPM and turns out to be the same for both cases. The results obtained show that accounting for financial risk properly significantly affects the assessment of the return on assets. It can be seen from Tables 5–10 that when kd exceeds kF, the financial risk premium becomes negative. It can also be seen in *Tables 1–6* that for companies from the extractive industries, such as Rosneft, Polymetal, and to a lesser extent Severstal, whose leverage level, due to the specifics of the industry is quite high, the premium for financial risk is high as well.

At the same time, companies with a typical level of leverage ranging from 0.5 to 1 (1.5) have a low financial risk premium compared to business risk (see *Tables 7–10*). This is well seen for Walt Disney Company (L is of order 0.5) and for Pfizer INC. (L is of order 1–1.5).

The proposed approach allows for making forecasts on the company's profitability without using the theory of capital structure. Estimated financial risk premiums depend on the level of leverage (capital structure) and the cost of borrowings. By planning the values of these parameters, the manager can predict the profitability of the company in the future. The novelty of the article lies in the development of a new approach that generalizes CAPM to account for both business and financial risks.

CAPM is one of the main models (along with APT (arbitrage pricing theory) and WACC) within the income approach to business valuation. This significantly increases the value of the developed CAPM 2.0 approach, which can significantly improve the accuracy of the assessment.

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Availability of data and materials

The authors have a database of dozens of companies from various countries supporting the findings of this article, which can be accessed upon reasonable request.

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V.L. Kulik — validation, formal analysis, investigation.

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