St. Petersburg State University
Graduate School of Management
Institute of Management

DISCUSSION PAPER

Dmitry Volkov, Irina Berezinets

ACCOUNTING-BASED VALUATIONS AND MARKET PRICES OF EQUITY: CASE OF RUSSIAN MARKET

#7(E)–2007

Saint Petersburg
2007

Dmitry Volkov, Irina Berezinets. Accounting-based valuations and market prices of equity: case of Russian market. Discussion Paper #7(E)–2007. Institute of Management, Graduate School of Management, Saint Petersburg State University, St. Petersburg, 2007.

This paper analyzes models of equity valuation which are based on accounting data of equity book value, net income, and residual earnings. Research is focused on the problem of validity of different analytical models which is defined by the ability of a model to produce fundamental valuations closely connected with market valuations of equity. This paper investigates versions of residual income model (RIM) under different modifications of linear information dynamics (LID). All models developed in this paper are tested on the data of Russian stock market from 2000 to 2005 year, which was booming during this period.
Results showed that accounting-based valuation models have good explanation characteristics on Russian emerging market. The version of RIM which rests on assumption that investors base their expectations about future amounts of net income totally on current net incomes gives highest correlation between fundamental and market valuations of equity amounted to R-square 0,83. The version of RIM which rests on assumption that investors base their expectations about future amounts of residual earnings totally on current residual earnings gives correlation between fundamental and market valuations of equity amounted to R-square 0,78. These results could prove a hypothesis about opacity of emerging markets: on these markets investors base their expectations mainly on current information which is available and relevant for forecasting.

Dmitry L. Volkov — Associate Professor, Head of Finance Theory Department, Deputy Dean, Graduate School of Management, St.Petersburg State University
e-mail: volkov@som.pu.ru

Irina V. Berezinets — Associate Professor, Finance Theory Department, Graduate School of Management, St.Petersburg State University
e-mail: berezinets@som.pu.ru

CONTENTS

INTRODUCTION TO THE PROBLEM: MANAGEMENT CONTEXT

It is impossible to create a modern system of company management without answering the question "what is the fundamental, basic objective of a company". The problem of determining such objective, as M. Jensen notes [Jensen, 2001], is at the heart of the modern global discussions on corporate governance.

There are two different approaches to answering this question [see, for example, Jensen, 2001; Wallace, 2003]. According to the first approach, the main objective of a company is to maximize its value both for the owners (i.e. equity) and for all capital suppliers (i.e. debt and equity). In this case the matter is that the target function of company is one-factor while maximization of total value of company makes society better. The second approach based on the stakeholders theory suggests that a corporation exists not only to provide benefit to its investors (owners and creditors) but also for the benefit of all the rest interested parties, such as employees, buyers, suppliers, local community and government. Thus, according to this approach, the target function of company is multifactor.

An important consequence of determining the target function of a company is the definition of specific values of a company performance or their relation system. The first approach implies that a company performance is measured by values that reflect change (creating or destruction) in value of a company for investors[1]. The second approach requires a multi-criteria system of performance evaluation. Balanced scorecard (BSC) is a classical example of such system

Without dwelling on the detailed critics of the stakeholders' theory we will make a note of just two basic moments. First of all, the stakeholders' theory gives rather a loose determination of these persons which in its turn doesn't allow defining clearly the target function of a company as it is unclear whose interests should be satisfied and to what extent. Thus, E.Freeman defines interested parties (stakeholders) as any person, or a group of people, who can influence the ability of company to reach its goals or can itself be affected in course of this process [Freeman, 1984]. Secondly, the midpoint of the multifactor definition of the target function is the problem of choosing between different objectives: what to do when they disagree (for example, the objective of company profit maximization can disagree with the objective of market share maximization), what objective is to be considered primary etc.

[1] For more detailed information on performance values in the framework of this approach see [Volkov, 2005a].

The management approach based on the idea of setting up a new value for a company owners as the main objective, has been called value-based management (*VBM*). The value-based management is defined as formal and systematic approach to company management aimed at achievement of the objective of maximization of the value created and maximization of value for shareholders in a long-term perspective [McTaggart, Kontes, Mankins, 1994]. At the same time, as Jensen notes [Jensen, 2001], setting of long-term value maximization as an objective by itself doesn't provide the management with a strategy for reaching this objective. In this context the stakeholders' theory and the techniques and instruments defined by it contribute to understanding of how value is built. The midpoint of the value-based management is the value measurement issue and the value creation process. As an element of the value-based management, valuation module implies choice of a model and procedures for determining the value of a company for its owners, monitoring changes in the value, defining drivers for creating a new value [Volkov, 2005b, p. 67]. Hence, the most important but still disputed issue is the problem of developing a company value measurement system for its shareholders. This presupposes selection of an adequate valuation model and developing a system of tools based on it, which allow taking decisions that contribute to the company value growth for shareholders on all levels of a company management.

Selection of a valuation model is a process of finding answers to two key questions. First is the question of acceptability of a model as a tool for a company management and second is the question of its reliability extent, i.e. how well the model can explain creation of a new value for shareholders. According to [Volkov, 2006], to solve the first problem one must answer a number of related questions such as, whether the value discounted in the model is the measure of a company performance for a certain period; whether the performance measure is related to the value that has been created for shareholders; how unambiguously the performance measure reflects creation or reduction of the value for shareholders; whether it is possible to build a decision-making system in a company based on the discounted metrics in the model; how effectively the performance measure (i.e. the parameter of a new value creation) solves the agency problem and coordinates the interests of owners and managers; whether it is possible to build the system of managers' incentives on the basis of the given metrics; how complex the metrics is; whether the metrics is understandable for managers and investors without specific education in the sphere of accounting and finance; whether it is possible to build a system of mechanisms in order to develop a new value on the basis of the model chosen and to "deliver" this system to every manager in order to make the individual

performance of certain managers contribute to the value growth for shareholders?

The key objective of this paper is answering the second of the questions, i.e. the question about the extent of reliability of valuation models. The extent of reliability of a model, first of all, depends on how close the fundamental valuations (received using a valuation model) are to the market valuations. In this paper we will focus on the valuation models based on accounting data (on the residual earnings model in particular).

The basic methodology of reliability research of accounting-based valuation models were laid by J. Ohlson [Ohlson, 1995; Feltham, Ohlson 1995]. Empiric testing of such evaluation models and figuring out their advantages over the dividend and cash flow discount models have been widely discussed in a number of works published over the last decade. G.Richardson and S.Tinaikar [Richardson, Tinaikar 2004] identify the two basic approaches of such publications: historical and forecasted. The historical branch implies defining the connection between the fundamental and market valuations on the basis of actually observed data from financial statements and actual market prices. Alternatively, the forecasted branch implies research of connection between forecasted data of financial statements and observable market prices. The most significant works within the framework of the historical approach are [Ohlson, 1995; Feltham , Ohlson, 1995, 1996; Bar-Yosef, Callen, Livnat, 1996; Dechow, Hutton, Sloan, 1999; Lee, 1999; Myers, 1999; Lo, Lys, 2000; Biddle, Peter, Zhang, 2001; Callen, Morel, 2001; Begley, Feltham, 2002; Easton, Pae, 2003] and in the forecasted approach — [Penman, Sougiannis, 1998, Courteau, Kao, Richardson, 2001]. This research as well as the previous work of one of the authors of this article [Bukhvalov, Volkov, 2005] belongs to the historical approach.

This work is a logical sequel of the series of published articles [Volkov, 2004 a, b; Bukhvalov, Volkov, 2005; Volkov, 2005 a, b], which were generalized in [Volkov, 2006]. This article was written in connection with accumulation of new statistical information on the Russian market as well as due to the necessity of a deeper theoretical substantiation of the accounting valuation models and the key assumptions underlying such models. Further in the paper we will define the models of residual income; discuss the details of the key assumptions underlying the models; formalize the model varieties in different modifications of the assumptions; make the econometric analysis of the received models on the basis of the Russian market data collected over the period from 2000 to 2005.

RESIDUAL INCOME MODEL: BASIC DEFINITIONS AND FORMULATIONS

In this paper we research accounting-based equity valuation models and in particular the residual income model. It is believed that the roots of the residual income model lie in the concept of economic income by Alfred Marshall [Marshall, 1890]. Interest to this concept revived in 60-70s of the 20th century so among the direct theoretical sources of the residual income model we can name the works of E.Fama, M.Miller and F.Modigliani [Fama, Miller, 1972; Miller, Modigliani, 1961], on the one hand, and E.Edwards and P.Bell [Edwards, Be11, 1961], on the other.

The *residual income model* (*RIM*) implies that the fundamental value of equity of a company depends on four factors: (a) amount of investments at the moment of valuation; (b) actual returns on investments; (c) required returns on investments; (d) invariability of spread of the results, i.e. ability of a company to generate returns on investment above the required. We will call the time slice when the spread of the results is achieved positive *the competitive advantage period*. After reformulating the key hypotheses of the residual income model we can say that the fundamental value of equity of a company is based upon the two main elements: (a) book value of equity at the moment of valuation; (b) discounted flow of residual incomes ensuring gain of the fundamental value over the book value of equity capital.

Thus, the key notion of this model is that of *residual income* (*RI*)[2] meaning the accounting income of a company after deduction of cost on capital. In general, the residual income value can be expressed as:

$$RI_j = \pi_j - k \times I_{j-1} \ , \qquad (1)$$

where RI_j — residual income of the reported (j-th) year;
π_j — accounting income of the reported year;
k — required returns on investments;
I_{j-1} — book value of investments at the beginning (at the end of previous year) of the reported year.

Depending on our understanding of the term investments (*I*) we can define the two basic variants of the residual income value: residual operating income and residual earnings of a company. Particularly note that in development of residual income values it is important to meet the requirement of accounting income value compliance and required returns on investments with the chosen definition of investment basis.

[2] Residual income in literature is also called 'abnormal earnings' (see, for example, [Ohlson, 1995]).

In other words, accounting income values, required returns on investments and book value of investments taken for the calculation of the residual income value should comply with each other.

Residual operating income (ReOI)[3] is a net operating income of a company after cost deduction on all company capital. In this case investments mean book value of net assets (*NA*) of a company. Consequently, we take here the value of net operating income for the income, i.e. the value of income before interest but after taxes (or earnings before interest - *EBI*)[4] and we take the rate of weighed average cost of all capital (*WACC*) — k_w for the required return. Then, the equation for calculation of residual income will be:

$$ReOI_j = EBI_j - k_W \times NA_{j-1}. \quad (2)$$

Residual earnings (RE) are a net comprehensive income of a company after deduction of cost of equity. In this case as investments into a company we understand the book value of equity (*E*). Consequently, as an income we take the value of net income — *N1*, and as a required return on investments – the rate of cost of equity k_E. Then, the equation for calculation of residual income will be:

$$RE_j = NI_j - k_E \times E_{j-1}. \quad (3)$$

Having discussed the notion and variants of residual income calculation we can define the residual income discounting model (*RIM*) in two ways: through residual operating income and residual earnings.

Residual operating income model (*ReOIM*) implies that the fundamental value of equity includes two elements: book value of equity at the moment of valuation and values of fundamental value growth above the book value defined in its turn as a continuous flow of residual operating incomes discounted by the rate of weighed average cost of all capital. In general, this model can be represented as:

$$V_E^{ReOIM} = E_0 + \sum_{j=1}^{\infty} \frac{ReOI_j}{(1+k_W)^j}. \quad (4)$$

Taking into consideration the basic balance-sheet equation, according to which the book value of equity is the difference between book values of assets and liabilities, the equation (4) can be presented as follows:

---

[3] The value of residual operating income introduced by Penman [Penman, 2001, p. 424] is, in essence, similar to economic profit by Copeland [Copeland, Koller, Murrin, 1995] and economic added value (EVA®) by Stewart [Stewart, 1999].

[4] In literature The *EBI* is also termed as *NOPAT* (Net Operating Profit After Taxes) [Stewart, 1999], or as *NOPLAT* (Net operating profit less adjusted taxes) [Cope1and, Koller, Murrin, 1995].

$$V_E^{ReOIM} = \left[NA_0 + \sum_{j=1}^{\infty} \frac{ReOI_j}{(1+k_W)^j} \right] - D_0 . \quad (5)$$

It is significant that the expression in square brackets of the equation (5) is a fundamental value of company or net assets of a company.

Generation of the residual operating income model (or the model of economic profit or economic value added) traditionally relates to the classical work by B.Stewart [Stewart, 1999]. Many works have been dedicated to the issue of development of this variant of the residual income model among which we should in particular mention a fundamental work of J.Grant [Grant, 1997].

Residual earnings model (*REM*) implies that the fundamental value of equity is formed by the two following elements: book value of equity at the moment of valuation and the amount of the fundamental value growth above the book growth defined, in turn, as a continuous flow of residual earnings discounted by the rate of equity cost of capital. In general, the equation for this model will be as follows:

$$V_E^{REM} = E_0 + \sum_{j=1}^{\infty} \frac{RE_j}{(1+k_E)^j} . \quad (6)$$

Generation of the residual earnings model is often related to the classical work of E. Edwards and P. Bell [Edwards, Bell, 1961]. A significant person contributed to the development of the area of focus is J.Ohlson whose works [Ohlson 1990; Ohlson 1991; Ohlson 1995; Feltham, Ohlson, 1995] allowed his successors to call this valuation model *Edwards-Bell-Ohlson (EBO) valuation model*[5]. Afterwards the analysis of the residual earnings model was developed in the works of S.Penman [Ou, Penman, 1989a; Ou, Penman, 1989b; Penman, 1992; Penman, 1998; Penman, Sougiannis, 1998; Penman, 2001; Penman, Yehuda, 2003], V.Bernard [Bernard 1993; Bernard 1995], C.Lee [Lee, 1996, 1999; Frankel, Lee, 1998], H.Ashbaugh and P.Olsson [Ashbaugh, Olsson, 2002], and in works of many others.

In [Volkov, 2004a] it is proved that the two variants of the residual income model are equivalent, i.e. they give the same fundamental value of equity. Therefore, in our further research we will consider the residual earnings model as a variant of the residual income model.

[5] The notation *EBO*-model was introduced by V.Bernard [Bernard, 1993]. Later this notation became widespread [see, for example, Lee, 1996; Frankel, Lee, 1998].

RESIDUAL INCOME MODEL: KEY ASSUMPTIONS

Further analysis of the residual income model requires research of the model key assumptions. The key assumptions of the model were formulated in such classical works as [Ohlson, 1995; Feltham, Ohlson, 1995]. The mentioned works became a methodological basis for the further research in this sphere. According to J.Ohlson [Ohlson, 1995] there are three key assumptions of the residual income model:

— assumption about the order of stocks and flows accounting;

— assumption about compatibility with the equilibrium dividend discount model;

— assumption about the dynamics of prognostic values of residual income.

Let us consider the specified hypotheses in more detail.

Assumption about the order of stocks and flows accounting implies adherence to the relationship called in accounting literature *clean-surplus relationship (CSR)* [Feltham, Ohlson, 1995, p. 694; Feltham, 2001, p. 238 — 249] (clean surplus of equity and, consequently, balance). The aforementioned relationship suggests that the value of equity (E) depends on two factors only. First, relations with owners expressed in obtaining additional funds from them and distributing financial results to their benefit in the form of dividends (d), and second, final performance of a company over the reported period expressed in the value of net comprehensive income (NI):

$$E_i = E_{i-1} + NI_i - d_i . \tag{7}$$

Assumption about compatibility with the equilibrium dividend discount model implies equivalence of the models in question. In general, the dividend discount model (DDM) can be put down as follows:

$$P = V_{E.}^{DDM} = \sum_{i=1}^{\infty} \frac{d_i}{(1+k_E)^i} , \tag{8}$$

where V^{DDM} — fundamental value of equity received using the dividend discount model;

P — market value of equity (market share price or market capitalization);

d_j — net dividends in j-th year of prediction;

k_E — required return on equity.

The dividend discount model (DDM) was first described in 1938 by John Williams [Williams, 1938], but theoretical completeness of this model is usually relates to the work of M.Gordon and E.Shapiro [Gordon, Shapiro, 1956]. Later the dividend discount model became rather popular. Fairly detailed description of this model can be found,

in particular, in such classical work on finance as [Sharpe, A1exander, Bailey, 1995]. Reliability of this model is proved by the fact that it is based on simple and commonly accepted notion that the fair value of security should be equal to the discounted value of cash receipts anticipated from this security [Sharpe, A1exander, Bailey, 1995, p. 590]. Financial receipts related to investments into shares are the dividends which a shareholder expects to receive in future [ibidem, p. 570]. Thus, the value of a share as an elementary part of equity and the basic value of equity as a whole are defined by the discounted flow of the anticipated dividends. It is significant that the dividend discount model is equilibrium, i.e. it is assumed that in this model the market and the basic values of equity are equal.

Let us show the equivalence of the dividend discount and the residual income models. If the clean-surplus relationship (7) is observed, then the value of paid dividends can be presented as:

$$d_i = E_{i-1} - E_i + NI_i = \left[E_{i-1} + NI_i\right] - E_i. \tag{9}$$

If through R_E we denote a value $R_E = k_E + 1$, where k_E — the required return on equity, then the equation for the residual earnings (3) can be defined as:

$$RE_i = NI_i - \left(R_E - 1\right) \times E_{i-1}. \tag{10}$$

After opening the brackets in (10) and rearranging the equation we receive:

$$E_{i-1} + NI_i = RE_i + R_E \times E_{i-1}. \tag{11}$$

Having substituted the formula (11) into the equation (9) we receive the formula relating the dividends of the period with the residual earnings for the same period:

$$d_i = RE_i - E_i + R_E \times E_{i-1}. \tag{12}$$

Using the received representation for the dividends (12) we substitute it into the equation (8). As a result we receive:

$$\begin{aligned} P_0 &= \sum_{i=1}^{\infty} \frac{d_i}{\left(1 + k_E\right)^i} = \sum_{i=1}^{\infty} \frac{d_i}{R_E^i} = \frac{d_1}{R_E} + \frac{d_2}{R_E^2} + \ldots = \\ &= \frac{RE_1 - E_1 + R_E \times E_0}{R_E} + \frac{RE_2 - E_2 + R_E \times E_1}{R_E^2} + \ldots = \\ &= E_0 + \left[\frac{RE_1}{R_E} + \frac{RE_2}{R_E^2} + \ldots\right] - \left[\frac{E_1}{R_E} + \frac{E_2}{R_E^2} - \frac{E_1}{R_E} - \ldots\right]. \end{aligned} \tag{13}$$

It is obvious that the formula in the second square brackets (13) is equal to null. Thus,

$$P_0 = E_0 + \left[\frac{RE_1}{R_E} + \frac{RE_2}{R_E^2} + \ldots \right] - 0 = E_0 + \sum_{i=1}^{\infty} \frac{RE_i}{R_E^i} =$$
$$= E_0 + \sum_{i=1}^{\infty} \frac{RE_i}{(1+k_E)^i}. \quad (14)$$

The received expression (14) is exactly the model of residual earnings (6) at the moment $t = 0$.

We can also show the equivalence of the residual income model with the valuation models based not on the book values of income but on the cash flows, and in particular, with the free cash flows discount model. The stated equivalence is specifically shown in [Volkov, 2004a]. S.Penman and T.Sougiannis [Penman, Sougiannis, 1998] proved that if the clean-surplus relationship is met then valuation models will differ only by the accounting treatment of stock and flows. Consequently, they will be equivalent in infinite intervals. At the same time, in transition from infinite to finite forecast horizons the models may give different results. Moreover, it may turn out to be difficult to use a number of models in practice. Thus, returning to the dividend discount model it worth saying that the specified model requires the existence of the hypothesis that dividend payments are infinite. Nevertheless, the hypothesis on the irrelevance of dividends made by M.Miller and F. Modigliani [Miller, Modigliani, 1961] shows that a share price doesn't depend on whether the actual dividend payment was made before or after the observable forecast horizon. Therefore forecasting of dividends during a finite horizon is not informative in relation to share value. Thus, as noted in [Penman, 1998], one should base valuation of shares (fundamental value of equity) on something more fundamental and significant than dividends. In connection with the argumentation above we can conclude that the dividend discount model should be considered not general but particular model of fundamental valuation, which use can only be reasonable in some particular cases. For example, S.Penman notes that the model can be reasonably used when dividend payments are permanently related to value building. This is possible when a company has an infinitely fixed rate of dividend payments meaning a fixed relationship of dividend payments and earnings for a reported period [Penman, 2001, p. 111].

Assumption about the dynamics of forecast values of residual income has been formulated by J.Ohlson [Ohlson, 1995] as a *linear information dynamics* (*LID*). Linear information dynamics is defined (see, for example, [Richardson, Tinaikar, 2004]) as a linear stochastic process expressing time change and relationship of accounting and non-

accounting information variables. *LID* allows making forecasts of future expected values of residual income on the basis of the actual values of accounting variables and other information in present. According to J.Ohlson [Ohlson, 1995], value of equity (P_t) is formed by the book value of equity (E_t), the linear function of the current residual earnings (*RE*) and the scalar variable representing other (non-accounting) information (θ_t):

$$P_t = E_t + \alpha_1 RE_t + \alpha_2 \theta_t . \tag{15}$$

Thus, the expected values of the variables included into the model (15) are defined by the following system of linear equations:

$$\begin{cases} RE_{t+1} = & w \times RE_t + \theta_t , \\ \theta_{t+1} = & \gamma \theta_t . \end{cases} \tag{16}$$

In their turn, the parameters of the process w ($0 \le w \le 1$) and γ ($0 \le \gamma \le 1$) are constant and "available" values. The coefficients of the equation (15) can be expressed using the parameters of the system (16) as follows [Ohlson, 1995, p. 669]:

$$\alpha_1 = \frac{w}{(R_E - w)} \ge 0,$$

$$\alpha_2 = \frac{R_E}{(R_E - w)(R_E - \gamma)} > 0. \tag{17}$$

FORMALIZATION OF RESEARCH MODELS

The basic valuation model (6) along with the assumptions about clean-surplus relationship (7) and the linear information dynamics (15) — (17) allows us to formulate a class of various valuation models based on historical data both of accounting and non-accounting character. The differences are based on the various assumptions about the parameters of the process determining the linear information dynamics.

First let us consider the classical model by J.Ohlson assuming that investors in defining the market share price base on accounting information only. This means that the process parameter $\gamma = 0$ and, consequently, the scalar variable reflecting other non-accounting information $\theta = 0$. With such hypothesis the linear dynamics of residual income (16) will be defined as:

$$RE_{t+1} = w \times RE_t . \tag{18}$$

We remember that the parameter w is changing in the interval from 0 to 1. Let us consider the marginal cases when $w = 1$ and $w = 0$.

First, assume that $w = 1$. In this case investors rest their expectations about future values of residual income completely on the current

(observable) value of this parameter, i.e. $RE_{t+1} = RE_t$. The α_1 coefficient from (17) in this case will be:

$$\alpha_1 = \frac{w}{(R_E - w)} = \frac{1}{(R_E - 1)} = \frac{1}{k_E}. \tag{19}$$

The basic valuation models (6) and (15) in this case are transformed as follows:

$$P_t = E_t + \sum_{j=1}^{\infty} \frac{RE_{t+j}}{(1+k_E)^j} = E_t + \frac{RE_{t+1}}{k_E} = E_t + \frac{RE_t}{k_E} .$$

Hence,

$$P_t = E_t + \frac{RE_t}{k_E}. \tag{20}$$

The model (20) means that the market share price is determined by the book value of equity at the moment of valuation (E_t) and by the infinite flow of expected residual earnings discounted at moment t on the rate of equity cost of capital. The stated flow with the accepted assumptions is a perpetuity of the observable value of residual earnings for the previous period ($t-1$, t).

Now assume that $w = 0$. This hypothesis brings us to the book value model under which the market share price is determined by the book value of equity at the moment of valuation. Indeed, if $w = 0$, the coefficient α_1 in (17) is equal to null and the value of the expected residual income RE_{t+1}, in accordance with the equation (16), is null as well. The basic valuation models (15) and (6) in this case transform respectively into the following:

$$P_t = E_t + \alpha_1 RE_t = E_t + 0 = E_t \quad ,$$

$$P_t = E_t + \sum_{j=1}^{\infty} \frac{RE_{t+j}}{(1+k_E)^j} = E_t + 0 = E_t \quad .$$

Hence,

$$P_t = E_t . \tag{21}$$

The hypothesis on null expected residual income means that investors expect that in the future the net income of company will cover only the capital costs, i.e.:

$$RE_{t+1} = NI_{t+1} - k_E \times E_t = 0_t ,$$

$$NI_{t+1} = k_E \times E_t . \tag{22}$$

The models (20) and (21) are based on the hypothesis that the expected values of residual earnings are equal and constant in the forecast infinite horizon (in the first case they are equal to the current value of residual earnings and in the second case they are equal to null). The dif-

ferences of the models lie in the parameter w taking the marginal values $w = 1$ and $w = 0$.

Let us continue our analysis assuming that if the basic hypothesis on the constant expected values of residual income are in force, the w parameter will take values in the interval $0 < w < 1$ in the next period $(t, t + 1)$ and $w = 1$ in further periods. In this case the linear dynamics excluding other non-accounting information may be expressed as:

$$NI_{t+1} = u \times NI_t . \tag{23}$$

Let us assume that the coefficient u in (23) is equal to one. This means that investors completely rest their expectations about the future values of net income upon the current value of this parameter. With the accepted hypothesis the equation (14) can be written as follows:

$$P_t = E_t + \sum_{j=1}^{\infty} \frac{RE_{t+j}}{(1+k_E)^j} = E_t + \frac{RE_{t+1}}{k_E} \quad ,$$

and

$$E_t + \frac{RE_{t+1}}{k_E} < E_t + \frac{RE_t}{k_E} \ . \tag{24}$$

Having decomposed the book value of equity at moment t into the factors in accordance with the clean-surplus relationship (7) and presented the residual earnings under the definition (3), we receive:

$$P_t = E_t + \frac{RE_{t+1}}{k_E} = E_{t-1} + NI_t - d_t + \frac{NI_{t+1} - k_E \times E_t}{k_E} =$$

$$= E_{t-1} + NI_t - d_t + \frac{NI_{t+1} - k_E \times (E_{t-1} + NI_t - d_t)}{k_E} =$$

$$= E_{t-1} + \frac{k_E \times NI_t - k_E \times d_t + NI_{t+1} - k_E \times E_{t-1} - k_E \times NI_t + k_E \times d_t}{k_E} =$$

$$= E_{t-1} + \frac{NI_{t+1} - k_E \times E_{t-1}}{k_E} \quad . \tag{25}$$

According to the hypothesis accepted by us that in the equation (23) the coefficient u = 1, i.e. $NI_{t+1} = NI_t$, the equation (25) can be represented as:

$$P_t = E_{t-1} + \frac{NI_{t+1} - k_E \times E_{t-1}}{k_E} = E_{t-1} + \frac{NI_t - k_E \times E_{t-1}}{k_E} = E_{t-1} + \frac{RE_t}{k_E}.$$

Hence,

$$P_t = E_{t-1} + \frac{RE_t}{k_E}. \qquad (26)$$

Thus, the model (26) means that the market share price is defined by the book value of equity at the beginning of the period proceeding the moment of valuation (E_{t-1}) and by the infinite flow of expected residual earnings discounted on the rate of equity cost of capital. The stated flow with the accepted hypothesis is perpetuity of the observable value of residual earnings in the previous period ($t-1$, t).

It is significant that the equation (26) represents the net income model under which the share price is determined exclusively by the flow of current accounting earnings discounted on the rate of equity cost of capital:

$$P_t = E_{t-1} + \frac{NI_t - k_E \times E_{t-1}}{k_E} = E_{t-1} + \frac{NI_t}{k_E} - E_{t-1} = \frac{NI_t}{k_E}. \qquad (27)$$

On the basis of the model (26) we can build a modified variant of the book value model. Let us assume that investors expect to receive in the future earnings covering only the equity cost of capital of the current period ($t-1$, t). With such hypothesis the value of the coefficient u can be developed from the following system of equations:

$$\begin{cases} NI_{t+1} = k_E \times E_{t-1} \\ NI_{t+1} = u \times NI_t \end{cases},$$

$$u = E_{t-1} \times \left(\frac{NI_t}{k_E}\right)^{-1}. \qquad (28)$$

In this case the valuation model will be as follows:

$$P_t = E_{t-1} + \frac{NI_{t+1} - k_E \times E_{t-1}}{k_E} = E_{t-1} + \frac{0}{k_E} = E_{t-1},$$

$$P_t = E_{t-1}. \qquad (29)$$

As we continue our analysis we can include in the interval under consideration not only the book information but also other non-book information, i.e. we can consider the situation when in the equation (16) the parameter $\gamma \neq 0$ and, consequently, θ in the equation (15) is more than null. In this case the share price can be represented as:

$$P_t = P_t^a + P_t'. \qquad (30)$$

where P_t^a — a part of the share price explained by accounting information;

P_t' — a part of the share price explained by other non-accounting information.

The first addend in the formula (30) is a fundamental value of equity (V_t), which by definition is the book value of equity plus the infinite flow of residual earnings. To determine the fundamental value we will choose one of the above models, for example, the model (26) with all the necessary assumptions. Then:

$$P_t^a \equiv V_t = E_{t-1} + \frac{RE_t}{k_E} \quad . \tag{31}$$

As for the second addend of the equation (30), we can assume that the value of the part of share price explained by other non-accounting information is a linear function of the similar value of the previous years. Thus:

$$P_t' = \varphi \times P_{t-1}' . \tag{32}$$

Performing further analysis of the variable P_{t-1}' we will note the two important circumstances. First, the moment (t – 1) is the moment in the past at which the value of the observable share price (P_{t-1}) may differ from the fundamental value received using a particular valuation model (V_{t-1}). Second, the deviation of the observable price from the fundamental value can itself be defined by some non-accounting information, and thus:

$$P_{t-1}' \equiv P_{t-1} - V_{t-1} . \tag{33}$$

As we have shown before, when the value of the expected earnings is constant ($NI = NI_{t+1}$)[6], the fundamental value is also constant: $V_t = const$. With the specified hypothesis the formula (33) can be rewritten as follows:

$$P_{t-1}' \equiv P_{t-1} - V_{t-1} = P_{t-1} - V_t \ . \tag{34}$$

If we substitute (34) into (32) we shall receive:

$$P_t' = \varphi \times \left(P_{t-1} - V_t\right) . \tag{35}$$

We shall substitute the formulas (31) and (35) into the equation (30) and receive:

$$P_t = V_t + \varphi \times \left(P_{t-1} - V_t\right) = V_t \times (1 - \varphi) + \varphi \times P_{t-1} . \tag{36}$$

As the φ coefficient may vary from 0 to 1 then, arguing as above, we shall consider the cases when this parameter takes the bound values. Let us assume that $\varphi = 0$. This means that the share price is determined exclusively by the accounting information, that is: $P_t = V_t$; $P_t' = 0$. Let φ = 1, which means that the share price is constant and equal to the observable value at

[6] To be more precise, not net but undistributed earnings. Nevertheless, the specified formal inaccuracy doesn't influence the further conclusions at the same time simplifying the presentation.

the moment (t – 1): $P_t = P_{t-1}$; $P'_t = P'_{t-1}$. In reality the value of the φ coefficient doesn't take the bound values, therefore $0 < \varphi < 1$.

Let us now substitute the formula of the fundamental value model (26) into the equation (36) and we will receive the complete model of the share price considering both the accounting and other non-accounting information:

$$P_t = \left(E_{t-1} + \frac{RE_t}{k_E} \right)(1-\varphi) + \varphi \times P_{t-1}. \tag{37}$$

Before proceeding to formalization of the econometric models for the analysis of adequacy of the formulated theoretical models to the empiric data, we shall make several general remarks.

In all the regression models considered by us as an explained variable we choose the market share price. Consequently, all the explanatory variables are taken not by their absolute values, but in relation to one share. This explains the difference of our models from the models analyzed in [Bukhvalov, Volkov, 2005] in which the authors take market capitalization (market price multiplied by the quantity of outstanding shares) as the explained variables and the explanatory variables are taken by their absolute values.

The question of choice of explained variable (price or capitalization) is debatable and requires further investigations. On the one hand, division of equity into shares is optional by the scale of a separate share and brings in a statistical error in connection with heteroscedacity of the model (different scales of the data). In this sense building of models in relation to price rather than in relation to capitalization "cuts off" the whole class of management applications of the model: forecasting of the capital value of closed companies and companies carrying out IPO (initial public offering). On the other hand, the price models have a higher power of explanation than the capitalization models. Thus, the analysis of the residual earnings model according to the data of the Russian market for 2000 — 2003, where the resulting value is market capitalization, gives the coefficient of determination R^2 = 0,61 [Bukhvalov, Volkov, 2005]. While the analysis of the model shown in this paper using the same data for the same period but in relation to market price gives the coefficient of determination R^2 = 0,89.

In this connection we should note that the goal of this research, as we have said before, is testing of the valuation models based on the accounting data with respect to their ability to explain the observable market prices. If a model can effectively explain prices, the fundamental valuations received in result of its use can serve as a measure of creation (destruction) of value for shareholders. And in this regard such valuations are

long-term by nature and can be a basis for building a system of performance measurement defining management compensation schemes and design of pension systems, systems of planning, budgeting etc.

Particularly complicated is the issue of comparison of accounting and market data in time. The matter is that the financial statements drawn up at moment t are published with a certain time lag. Furthermore, market needs an additional time to respond to new accounting data. Therefore, comparison of the share price (P_t) observable at moment t with the accounting data at the same moment will be not quite correct, as the price P_t doesn't actually include the accounting data at moment t. To solve the stated problem in our models the accounting information at moment t is compared to the market price with a certain time lag τ ($0 < \tau < 1$) allowing the market prices to "respond" to the incoming accounting information.

Let us precede to the consideration of one-factor linear regression models. First, we will consider one-factor econometric models of equity book value. They are defined by the equations (29) and (21) respectively and based on the assumptions accepted by us in their substantiation.

$$P_{t+\tau,i} = \beta_0 + \beta_1 E_{t-1,i} + e_{1,t+\tau,i}. \quad \text{(M1)}$$

$$P_{t+\tau,i} = \lambda_0 + \lambda_1 E_{t,i} + e_{2,t+\tau,i}. \quad \text{(M2)}$$

In the model (M1) we use the following notations:

$P_{t+\tau,i}$ — market price of shares of i-th company at moment $(t + \tau)$;

$E_{t+\tau,i}$ — equity book value of i-th company at moment $(t + \tau)$;

β_0, β_1 — unknown parameters of the regression model;

$e_{1,t+\tau,i}$ — a random variable characterizing the factors not considered in the model (M1).

In the model (M2) all the variables have the same meaning as in (M1) except for the fact that equity book value of i-th company per share is calculated not at the moment $(t - 1)$ but at the moment t. The unknown parameters of this model are denoted via λ_0, λ_1, and $e_{2,t+\tau,i}$ denotes a random variable.

In the two-factor econometric models the market share price is explained not only by the equity book value per share but also by the historic value of residual earnings. These models are built on the basis of the equations (26) and (20) respectively and based on the assumptions accepted by us in their theoretical substantiation:

$$P_{t+\tau,i} = \mu_0 + \mu_1 E_{t-1,i} + \mu_2 RE^*_{t,i} + e_{3,t+\tau,i}, \quad \text{(M3)}$$

$$RE^*_{t,i} = \frac{RE_{t,i}}{k_E} = \frac{NI_{t,i} - k_E \times E_{t-1,i}}{k_E}, \quad \text{(M3a)}$$

$$P_{t+\tau,i} = \eta_0 + \eta_1 E_{t,i} + \eta_2 RE^*_{t,i} + e_{4,t+\tau,i}. \quad \text{(M4)}$$

$RE^*_{t,i}$ in the models (M3) and (M4) means (see M3a) a perpetuity of the residual earnings of the period (t – 1, t) of i-th company per share. The coefficients μ_0, μ_1, μ_2 and η_0, η_1, η_2 are the unknown parameters of the models (M3) and (M4), respectively, and $e_{3,t+\tau,i}$ and $e_{4,t+\tau,i}$ — random variables of the stated models. The meanings of the other variables included in the models (M3) and (M4) were explained in the description of the models (M1) and (M2).

The three-factor model apart from the accounting variables (book value of equity and perpetuity of residual earnings) also includes a lag variable — market share price at the moment ($t + \tau - 1$). It is significant that inclusion of the lag variable, as we have shown earlier, allows explaining the share price at the given moment both by the accounting and other (non-accounting) information. The specified model is built on the basis of the formula (37) and the assumptions accepted by us in its substantiation:

$$P_{t+\tau,i} = \chi_0 + \chi_1 E_{t-1,i} + \chi_2 RE^*_{t,i} + \chi_3 P_{t+\tau-1,i} + e_{5,t+\tau,i}, \quad \text{(M5)}$$

where $P_{t+\tau-1,i}$ — observable price of a share of i-th company in the preceding year (at moment ($t + \tau - 1$)); $\chi_0, \chi_1, \chi_2, \chi_3$ — unknown parameters of the model; $e_{5,t+\tau,i}$ — random variable of the model.

STATISTICAL DATA

As basic statistical information in this paper we use the database created by one of the authors and used in the research which results were published in [Bukhvalov, Volkov, 2005]. The stated database included the data of 47 nonfinancial companies trading their shares in the RTS (Russian Trading System) stock exchange. The period of the research was limited to two years: the accounting data was taken for the period 2000 — 2002, and the market data – for the period 2002 — 2003. Thus, the total size of the sample was 94 company-years (47 companies for 2 years).

The above mentioned database has been supplemented by the other author of this research from the same sources for the period 2003 — 2005. As in [Bukhvalov, Volkov, 2005], for calculation of the key financial values the authors took the data on the issuing companies listing and trading their ordinary shares on the RTS stock exchange. However, the research didn't include shares of banks and other financial institu-

tions. Due to dynamics of the market, “disappearing” from the market of shares of one companies and “appearing” of shares of new companies the list of companies participating in the analysis was reviewed. After the review the research included 31 company.

As the basic statistical data in the research the authors used the data of published financial statements of the companies included into the sample for the period 2000 — 2004 which was taken from the site www.skrin.ru as well as the resulting data of trading ordinary shares of these companies on the RTS stock exchange in 2001 — 2005. The latter information was taken from the site www.rts.ru. Thus, the total size of the sample was 124 company-years: 31 company during 4 years.

It is worth saying that all the data was submitted in accordance with the Russian standards of financial accounting. The units of the data were equal to USD and the financial data presented in RUR was converted into USD at the RF Central Bank exchange rate at the end of the reported period. The key accounting data was taken from the unconsolidated financial statements of the issuers. Substantiation of choice of the unconsolidated financial statements is given in [Bukhvalov, Volkov, 2005].

For calculation of the market share price the authors took the average rates of the ordinary shares listed in the RTS weighed with regard to the trading volume. The average-weighed rate of shares was calculated on the basis of the data of the respective year *second quarter*. This means that the time lag τ was two quarters of a year. Such a lag is explained by the fact that financial statements of companies for the previous year are usually published during the second quarter of the reported year. Besides, there is quite a usual occurrence in the Russian market called “planned adjustment” of price due to appearance of new accounting information particularly in the second quarter of a reported year.

A significant question is how to choose the required return on equity k_E. The stated rate directly influences the perpetuity value of residual earnings. Just as in [Bukhvalov, Volkov, 2005], the authors assume that the required returns to equity are the same for all the companies included into the sample and amounts to 30%. Though the substantiation of this hypothesis lies beyond the frameworks of our research, it is worth saying that, as shown in [Bukhvalov, Volkov, 2005], the value of the required yield is not a relevant parameter that allows making conclusions about the relationship between the market capitalization and the accounting book values of equity and residual earnings (though in calculation of the latter the required returns to equity is used directly). The stated conclusion coordinates with the results of the research [Pen-

man, Sougiannis, 1998]. These authors analyzed various models in terms of their ability to explain market share prices using different methods of valuation of the required returns to equity. For example, they used such methods as risk-free rate for the corresponding calendar year plus the uniform risk premium for investing into equity; the equity cost of capital received using the capital asset pricing model (*CAPM*); the cost of equity capital for the industry of the respective company on the basis of the three-factor model by Fama and French [Fama, French, 1997]; the uniform optional rate for all the companies and all the years of research. It is the last approach we use in our research. S.Penman and T.Sougiannis showed that the differences in results of different ways of calculation of the cost of capital are not great and that apparently the reasonable adjustment to risk can not explain the results received.

RESULTS OF RESEARCH

After the econometric model has been chosen, the further work in the econometric analysis is related with the estimation of the unknown parameters of the model and analysis of its adequacy to the empiric data. The analysis of adequacy includes test of the hypothesis on the significance of the model using the Fisher's test, checking of the hypotheses on the significance of the factors included into the model using the Student's test.

As we know, an econometric model should fit the frameworks of a classical normal regression model. That is, it should meet a number of probabilistic hypotheses in respect to the random elements of the model. The specific character of the data used in this paper implies that the hypothesis on homoscedacity of the model's errors will not be obviously met. This was proved in testing of each model for heteroscedacity. To eliminate the heteroscedasticity and improve the quality of estimator, all the models were valued using the method of generalized least squares. For each multifactor model the analysis of the factors for multicollinearity was performed. Statistic analysis of the coefficients of correlation among the factors allowed making a conclusion about absence of pair relationship among the factors.

Let us consider the results of estimation of the regression models and write out the received regression functions for the models of book value of equity (M1) and (M2) for a three year period (2001— 2004):

$$\hat{P}_{t+\tau} = 0.97 + 1.21 \times E_{t-1}, \tag{38}$$

$$\hat{P}_{t+\tau} = 0.86 + 1.08 \times E_t \ . \tag{39}$$

And for a four year period (2001 — 2005):

$$\hat{P}_{t+\tau} = 1.41 + 1.20 \times E_{t-1}. \quad (40)$$

$$\hat{P}_{t+\tau} = 1.23 + 1.07 \times E_t \ . \quad (41)$$

To test the basic hypothesis on the significance of the model let us introduce the following notations: using R^2 we shall note the theoretical coefficient of determination, and using $\hat{R}^2$ — its sample estimator. The hypotheses (null and alternative) on the significance of the one-factor linear regression model can be formulated as follows:

$$H_0\text{: } R^2 = 0;$$
$$H_1\text{: } R^2 \neq 0.$$

The hypotheses are tested in accordance with the F-test. The sample statistics is calculated under the formula: $F = \dfrac{\hat{R}^2(n-2)}{1-\hat{R}^2}$. If the null hypothesis is true, the specified random value has a F-distribution with the $v_1 = 1$, $v_2 = n - 2$ degrees of freedom. The rejection region is right-handed and its bound k_2 is found using the Fisher's distribution tables by the set level of significance and the specified number of freedom degrees. If $F \geq k_2$, one can accept the alternative hypothesis and make the conclusion about the statistical significance of the regression model. If $0 < F < k_2$, one can accept the null hypothesis and make the conclusion that the model is not statistically significant. In other words, in the first case one concludes that the dependent variable and independent variable have the linear relationship; in the second case one concludes that either there is no relationship or it is not linear. Testing of the hypothesis on the significance of the factor influence on the dependent variable implies testing of the hypothesis that the unknown coefficient is equal to null before the explanatory variable. For example, for the model (M1) null and alternative hypotheses can be formulated as follows:

$$H_0\text{: } \beta_1 = 0;$$
$$H_1\text{: } \beta_1 \neq 0.$$

Testing of the null hypotheses is performed using the t-test. For this purpose one usually calculates the sample statistics under the formula $t^* = b_1 / S_{b1}$, where b_1 denotes a point estimator of the unknown parameter β_1 and S_{b1} denotes a standard error of this estimator. If the null hypothesis is true, the specified statistics will have the t distribution with $v = n - 2$ number degrees of freedom. In the formulated alternative hypothesis the rejection region will be two-sided. The bound k_2 of this region is found using the t distribution tables by the set level of significance and the specified number degrees of freedom, k_1

$= -k_2$. If $k_1 < t^* < k_2$, one should accept the null hypothesis that the β_1 coefficient is not significantly different from 0 and hence the factor corresponding to this coefficient significantly influences the dependent variable. When the inequality $|t^*| \geq k_2$ is true one concludes that the unknown coefficient significantly differs from null and the corresponding factor influences the explained variable. The results of statistical estimation of the models of book value of equity (M1) and (M2) are shown in Table 1.

Table1

Results of statistical analysis of the models (M1) and (M2)

Model / explanatory variable	**(M1)/ E_{t-1}**		**(M2) / E_t**	
Observation period	**3 years (2000/04)**	**4 years (2000/05)**	**3 years (2000/04)**	**4 years (2000/05)**
1 . Point estimators of the unknown coefficients of the regression function				
— free term of the regression function	0.97	1.41	0.86	1.23
— coefficient before the explanatory variable	1.21	1.20	1.08	1.07
2. *F*-test				
— number degrees of freedom	v_1=1; v_2=91	v_1=1; v_2=122	v_1=1; v_2=91	v_1=1; v_2=122
— bound of the right-handed rejection region (5 % sign.level)	3.946	3.920	3.946	3.920
— value of *F*-statistics for testing the hypothesis about the significance of the model	158.76	267.00	180.53	263.81
3. *t*-test				
— number degrees of freedom	v = 91	v =122	v = 91	v =122
— boundaries of the two-sided rejection region (5% sign. level)	k_1=–1.986; k_2 = 1.986	k_1=–1.986; k_2 = 1.986	k_1=–1.986; k_2 = 1.986	k_1=–1.986; k_2 = 1.986
— value of *t*-statistics for estimator of the coefficient before the explanatory variable	12.60	14.99	13.43	16.24
4. Confidence intervals for the unknown coefficients before the explanatory variable (confidence probability 0,95)				
— lower bound	1.02	0.69	0.92	0.94
— upper bound	1.40	1.03	1.24	1.21
5. Sample coefficient of determination R^2	**0.63**	**0.65**	**0.68**	**0.68**

Analyzing the results received we can conclude that the said models have a good explaining ability and the hypothesis on dependence of the market share price on the book value of equity per share is statistically significant for the Russian market. At the same time the model (M2), in which the book value of equity at moment t serves as a factor variable, is better than the model (M1), in which the independent variable is the book value of equity at moment $(t - 1)$.

Let us precede with the analysis of the two-factor regression functions. As a result we received the following regression functions for the models (M3) and (M4), respectively, using the observation data for three years (2000-2004):

$$\hat{P}_{t+\tau} = 1.91 + 1.22 \times E_{t-1} + 0.55 \times RE_t^*, \tag{42}$$

$$\hat{P}_{t+\tau} = 2.01 + 1.02 \times E_t + 0.42 \times RE_t^* . \tag{43}$$

According to the observation data for four years (2000 — 2005) the equation of the regression function for the regression models (M3) and (M4) will be as follows:

$$\hat{P}_{t+\tau} = 1.997 + 1.27 \times E_{t-1} + 0.553 \times RE_t^*, \tag{44}$$

$$\hat{P}_{t+\tau} = 2.07 + 1.06 \times E_t + 0.20 \times RE_t^* . \tag{45}$$

Just as in the case with the one-factor linear regression models we have performed the analysis of significance both of the entire model and the factors included into it. Let us illustrate it on the example of the model (M3).

In order to test the two-factor model (M3) for significance we shall propose the following null and alternative hypotheses:

$$H_0 : \mu_1 = 0, \mu_2 = 0 ,$$

$$H_1 : \mu_1 \neq 0, \mu_2 \neq 0 .$$

Calculation of the sample statistics for testing of the hypotheses is done under the formula:

$$F = \frac{\hat{R}^2}{(1 - \hat{R}^2)} \frac{(n - m)}{(m - 1)}, \tag{46}$$

where n — sample size, $(m - 1)$ — number of factors in the model, m — number of he unknown coefficients. If the null hypothesis is true, this statistics will be distributed under the F-rule with $v_1 = m - 1$, $v_2 = n - m$ degrees of freedom. The rejection region is right-handed. The bound of the rejection region is being found using the Fisher's tables. Further actions to accept or reject the null hypothesis are performed in accordance with the algorithm shown for the one-factor linear regression model.

To answer the question about the significance of the explanatory variables included into the model for each factor we propose and test the following hypotheses:

$$H_0: \quad \mu_1 = 0 \; H_1: \quad \mu_1 \neq 0,$$
$$H_0: \quad \mu_2 = 0 \; H_1: \quad \mu_2 \neq 0.$$

The sample statistics for testing the hypotheses is calculated under the formula: $t^* = m_j / S_{mj}$, $j = 1, 2$, where m_j denotes the point estimator of the unknown parameter μ_j and S_{mj} denotes the standard error of these estimators. The algorithm for testing of the hypotheses is the same as the algorithm in the Student's test for the one-factor linear regression model. The results of statistical calculations for testing the null hypotheses for the models (M3) and (M4) are presented in Table 2.

Test of the hypotheses using the *t*-test definitely points to the fact that the null hypotheses in all the cases should be rejected and accordingly the regression coefficients, and hence the corresponding factors are statistically significant. The *F*-test also allows us to accept the statistical hypothesis on significance of the analyzed two-factor models on the basis of the data both for three and four years.

Having compared the results of the analysis of the one-factor linear regression models (M1) and (M2) with the results received in the analysis of the two-factor models (M3) and (M4) we can make a definite conclusion that the latter models have better explaining ability for all the parameters. At the same time it is obvious that while the regression model (M4) is statistically significant it is less effective than the model (M3) in all respects.

Table 2

Results of statistical analysis for the models (M3) and (M4)

Model/ explanatory variables	**(M3)/E_{t-1}; *RE****		**(M4)/E_t; *RE****	
Observation period	**3 years (2000/04)**	**4 years (2000/05)**	**3 years (2000/04)**	**4 years (2000/05)**
1	*2*	*3*	*4*	*5*
1. Point estimators of the unknown coefficients of the regression function				
— coefficient before the first free term of the regression function	1.91	1.997	2.01	2.07
— coefficient before the first explanatory variable	1.22	1.27	1.02	1.62
— coefficient before the second explanatory variable	0.55	0.553	0.42	0.41

Table continued on next page.

1	*2*	*3*	*4*	*5*
2. *F*-test				
— number degrees of freedom	v_1=2; v_2=90	v_1=2; v_2=121	v_1=2; v_2=90	v_1=2; v_2=121
— bound of the right-handed rejection region (5% significance level)	3.098	3.071	3.098	3.071
— value of *F*-statistics for testing of the hypothesis on significance of the model	235.24	303.83	160.11	224.95
3. *t*-test				
— number degrees of freedom	v=90	v=121	v=90	v=121
— bounds of the two-sided rejection region (5% significance level)	k_1 =–1.987 k_2 = 1.987	k_1= –1.97 k_2 = 1.97	k_1= –1.987 k_2 = 1.987	k_1 = –1.97 k_2 = 1.97
— value of *t*-statistics of the estimators coefficient before the first explanatory variable	19.04	22.85	15.53	19.57
— value of *t*-statistics of the estimators coefficient before the second explanatory variable	10.69	11.63	6.86	7.72
4. Confidence intervals for the unknown coefficients before the explanatory variables (confidence probability 0,95)				
— for the coefficient (μ_1, η_1) before the first variable				
▪ lower bound	1,09	1,16	0,89	0,96
▪ upper bound	1,35	1,38	1,15	1,17
— for the coefficient (μ_2, η_2) before the second explanatory variable				
▪ lower bound	0,45	0,46	0,30	0,31
▪ upper bound	0,65	0,65	0,54	0,52
5. Coefficients of determination:				
sample R^2	0,839	0,835	0,780	0,775
adjusted R^2_{adj}	**0,831**	**0,830**	**0,788**	**0,784**

Considering the better statistical characteristics of the model (M3) let us perform its additional analysis answering the two questions: first, how closely the explanatory variables included into the model are related to each other; second, how well the model can retain its statistical characteristics in time.

To answer the first question we shall analyze the matrix of sample correlation coefficients. For the two-factor residual earnings model this matrix can, in general, be written as follows:

$$V = \begin{pmatrix} 1 & \rho_{pE} & \rho_{pRE} \\ \rho_{pE} & 1 & \rho_{E\,RE} \\ \rho_{pRE} & \rho_{E\,RE} & 1 \end{pmatrix}. \quad (47)$$

The matrix (47) for the variables included into the model (M3) for the three-year (V_3) and the four-year (V_4) periods of observation was as follows:

$$V_3 = \begin{pmatrix} 1 & 0.797 & 0.439 \\ 0.797 & 1 & -0.016 \\ 0.439 & -0.016 & 1 \end{pmatrix}, V_4 = \begin{pmatrix} 1 & 0.805 & 0.343 \\ 0.805 & 1 & -0.100 \\ 0.343 & -0.100 & 1 \end{pmatrix}. \quad (48)$$

The values of the sample coefficients of correlation between the factor variables both for the three-year (–0.016) and the four-year (–0.1) periods allow us to characterize the relationship among the variables as a weak and statistically invalid one.

To answer the second question we swill show how the basic statistical characteristics of the model (M3) change with increase of the observation period. The data presented in Table 3 one more time allow us to make sure that the two-factor residual earnings model retains the statistically stable behavior in all the considered time intervals.

Table 3

Basic statistical characteristics of the model (M3) / $E_{t\text{-}1}$; RE^*_t for various observation periods

Statistical characteristics	**For 1 year (2000/02)**	**For 2 years (2000/03)**	**For 3 years (2000/04)**	**For 4 years (2000/05)**
1. Value of the coefficient of determination R^2	0.87	0.89	0.84	0.83
2. Value of *F*-statistics	95.87	247.26	235.41	303.83
3. Value of *t*-statistics of the estimators coefficient before the first explanatory variable	7.62	12.21	19.04	22.85
4. Value of *t*-statistics of the estimators coefficient before the second explanatory variable	3.03	4.73	10.69	11.63
5. Estimator of the free term of the equation	0.59	0.81	1.91	1.997
6. Estimator of the coefficient before the first explanatory variable	1.51	1.46	1.22	1.27
7. Estimator of the coefficient before the second explanatory variable	0.83	0.81	0.55	0.553

Let us now consider the last model (M5) where in order to take into account the specific character of the market changes we include a lag variable: a value of the market price at the preceding moment. For this model we have received the following equation of the regression function:

$$\hat{P}_{t+\tau,i} = 2.02 + 0.60E_{t-1,i} + 0.55RE^{*}_{t,i} + 0.61P_{t+\tau-1,i}. \quad (48)$$

Table 4

Results of statistical estimation for the model (M5)

Model/ explanatory variables	**(M5)/ E_{t-1}; RE^{*}_{t}; $P_{t+\tau-1}$**
Observation period	**4 years (2000/05)**
1	*2*
1. Point estimators of the unknown coefficients of the regression function:	
— free term of the regression equation	2.02
— coefficient before the first explanatory variable	0.60
— coefficient before the second explanatory variable	0.55
— coefficient before the third explanatory variable	0.61
2. *F*-test	
— number degrees of freedom	v_1= 3; v_2=59
— bound of the right-handed rejection region (5% level of significance)	2.76
— value of *F*-statistics for testing of the hypothesis on the significance of the model	112.89
3 . *t*-test	
— number degrees of freedom	v = 59
—bounds of the two-sided rejection region (5% significance level)	k_1 = – 2.00 k_2 = 2.00
— value of *t*-statistics for estimator of the coefficient before the first explanatory variable	2.57
— value of *t*-statistics for estimator of the coefficient before the second explanatory variable	8.88
— value of *t*-statistics for estimator of the coefficient before the third explanatory variable	2.62
4. Confidence intervals for the unknown coefficients before the explanatory variables (confidence probability 0,95)	
— for the coefficient (χ_1) before the first explanatory variable	
o lower bound	0.13
o upper bound	1.07

Table continued on next page.

1	*2*
— for the coefficient (χ_2) before the second explanatory variable	
o lower bound	0.43
o upper bound	0.67
— for the coefficient (χ_3) before the third explanatory variable	
o lower bound	0.14
o upper bound	1.08
5. Coefficients of determination:	
sample R^2	0.854
adjusted R^2_{adj}	**0.846**

The results of the statistical estimation for the model (M5) are given in Table 4. The analysis of the statistical estimation results of the model (M5) has shown that the regression coefficients and hence the respective factors are statistically significant. Comparing the analysis results of the two-factor models (M3) and (M4) with the results obtained from the analysis of the three-factor model (M5), it is possible to notice that the value of the adjusted coefficient of determination R^2 in the three-factor model is higher than in the two-factor models. This means that the inclusion into the model of the variables representing not only the accounting but also other non-accounting information (the lag variable in our case) improves the explaining ability of the model. At the same time in regard to the other characteristics such as the *F*- and *t*-tests, the three-factor model (M5) is less effective compared not only with the two-factor models (M3) and (M4) but also the one-factor linear regression book value models (M1) and (M2).

In conclusion of this paper it is worth noting that the analysis of all the models considered here for heteroscedasticity was performed using the Spearman's rank correlation test and the Goldfeld-Quandt test. Heteroscedacity was found in all the models and therefore in building of the regression functions we used the method of generalized least squares. In the multifactor models we didn't find the signs of multicollinearity.

CONCLUSION

In this work we have investigated accounting-based equity valuation models in terms of their reliability. Under the reliability of the valuation model we understand the ability of the fundamental valuations received using a certain model to explain the observable market valuations.

Empiric testing of the valuation models has two basic approaches in the world accounting literature: historical and forecasted. This research has been performed in the frameworks of the historical approach. This approach implies defining of the relation between the fundamental and market valuations on the basis of the observable (forecasted in the forecasted approach) financial statements data of companies and the existing market prices. Taking into consideration the fact that the value of equity is defined by the expected future payments, the methodology of the historical research approach requires formulation of the hypothesis on the investor's expectations. As a toolkit for forecasting of the future expected values of the accounting parameters such as residual income, in particular, we use the linear information dynamics *(LID),* which is defined as a linear stochastic process that reflects the changes in time and relationship of the accounting and non-accounting variables.

Various assumptions underlying the linear information dynamics allow us to formulate the entire class of valuation models with different explaining abilities. In this research we have formulated five valuation models and performed their empiric testing based on the data of the Russian market in the period of 2000 — 2005. The results of the research performed have shown that all the five formulated accounting-based valuation models are reliable and have good explanatory characteristics. However, they can be ranged under the above criterion.

If we assume that in estimation of the market share price investors are only focused on the accounting information leaving aside other non-accounting information, then the best explaining ability in all respects belongs to the model (M3) (the adjusted coefficient of determination R^2_{adj} = **0.83**). According to the model (M3) the market share price is defined by the book value of equity at the beginning of the period preceding that of valuation and by the perpetuity of the observable value of residual earnings during the previous period. This model is based on the hypothesis that investors completely rest their expectations in respect to the future values of net income upon the current value of this parameter. In fact this model is the model of net income, under which the share price is determined exclusively by the flow of net income discounted by the rate of equity cost of capital.

The second place in terms of a degree of reliability holds the model (M4) (the adjusted coefficient of determination R^2_{adj} = **0.78**). According to this model the market share price is defined by the book value of equity at the moment of valuation and by the perpetuity of the observable value of residual earnings for the previous period. This model is based on the hypothesis that investors rest their expectations in respect to future values of net income upon the current value of this parameter.

The third place in this regard is taken by the book value model (M2) with the coefficient of determination R^2 = **0.68**. According to this model the market share price is defined by the book value of equity at the moment of valuation. This model is based on the hypothesis on the null expected residual income meaning that investors expect that the earnings of the given company in the future will cover the capital costs only. The worst results with the coefficient of determination R^2 = **0.65** has shown the book value model (M1). According to this model the market share price is defined by the book value of equity at the beginning of the period preceding the moment of valuation. This model is based on the hypothesis that if the residual earnings in the current period are not equal to null, investors expect null residual earnings in the future.

Adding of other non-accounting information expressed in the model (M5) by the lag variable (market share price in the preceding period) into the valuation models is contradictory by nature. On the one hand, the coefficient of determination R^2 slightly improves compared to the best of the exclusively accounting models (M3) reaching the value of **0.85**. Judging by the other characteristics (*t*-statistics, *F*-statistics), however, on the other hand, the model (M5) cannot compete with the considered models based exclusively upon the accounting information.

In conclusion of the paper we can determine the basic directions of the further research in this sphere. Firstly, empiric testing of the discussed models will develop with accumulation of new statistical information for the purpose of stability detection of the models. Secondly, following the historical direction it is possible to build other models with other assumptions about information dynamics of both linear and non-linear nature. Thirdly, availability of the analysts' forecasts with respect to the dynamics of the accounting values will give an opportunity to empirically test the models within the frames of the forecasted research approach.

.

REFERENCES

1. *Ashbaugh H.*, *Olsson P.* An Exploratory Study of the Valuation Properties of Cross-Listed Firms' IAS and U.S. GAAP Earnings and Book Values // Accounting Review. 2002. **77** (1): 107 — 126.
2. *Bar-Yosef S., Callen J., Livnat J.* Modeling Dividends, Earnings, and Book Value Equity: An Empirical Investigation of the Ohlson Valuation Dynamics // Review of Accounting Studies. 1996. **1**: 207 — 224.
3. *Begley J.*, *Feltham G.* The Relation between Market Values, Earnings Forecasts, and Reported Earnings // Contemporary Accounting Research. 2002. **19**: 1 — 48.
4. *Bernard V.* Accounting-based Valuation Methods, Determinants of Market-to-book Ratios, and Implications for Financial Statement Analysis. 1993. Working Paper. University of Michigan.
5. *Bernard V.* The Feltham–Ohlson Framework: Implications for Empiricists // Contemporary Accounting Research. 1995. **11** (2): 733 — 747.
6. *Biddle G.*, *Peter C., Zhang G.* When Capital Follows Profitability: Non-linear Residual Income Dynamics // Review of Accounting Studies. 2001. **6**: 229 — 265.
7. *Bukhvalov A., Volkov D.* Study of interdependence between fundamental value and market capitalization of Russian companies. // Vestnik (Herald) of St. Petersburg University. Series: Management. 2005. (1): 26 — 44 (In Russian: *Бухвалов А.В., Волков Д.Л.* Исследование зависимости между фундаментальной ценностью и рыночной капитализацией российских компаний // Вестник С.-Петербургского ун-та. Сер. Менеджмент. 2005. (1): 26 — 44).
8. *Callen J.*, *Morel M.* Linear Accounting Valuation when Abnormal Earnings are AR (2) // Review of Quantitative Finance and Accounting. 2001. **16**: 191 — 204.
9. *Copeland T., Koller T., Murrin J.* Valuation: Measuring and Managing the Value of Companies. 2nd ed. — N.Y.: John Wiley & Sons, Inc., 1995.
10. *Courteau L., Kao J., Richardson G.* Equity Valuation Employing the Ideal Versus Ad Hoc Terminal Value Expressions // Contemporary Accounting Research. 2001. **18** (4): 625 — 661.
11. *Dechow P.*, *Hutton A., Sloan R.* An Empirical Assessment of the Residual Income Valuation Model // Journal of Accounting and Economics. 1999. **26**: 1 — 34.

12. *Easton P.*, *Pae J.* Accounting Conservatism and the Regression of Returns on Earnings and Earnings Changes. 2003. Working Paper. University of Notre-Dame, Notre-Dame, IN, USA.
13. *Edwards E.*, *Bell P.* The Theory and Measurement of Business Income. — Berkeley, CA: University of California Press, 1961.
14. *Fama E.*, *Miller M.* The Theory of Finance. — New York. 1972.
15. *Fama E.*, *French K.* Industry Costs of Equity // Journal of Financial Economics. **43** (2): 153 — 193.
16. *Feltham G.*, *Ohlson J.* Valuation and Clean Surplus Accounting for Operating and Financial Activities // Contemporary Accounting Research. 1995. **11** (2): 689 — 731.
17. *Feltham G.*, *Ohlson J.* Uncertainty Resolution and the Theory of Depreciation Measurement // Journal of Accounting Research. 1996. **34**: 209 — 234.
18. *Frankel R.*, *Lee C.* Accounting Valuation, Market Expectation, and Cross-sectional Stock Returns // Journal of Accounting and Economics. 1998. **25** (3): 283 — 319.
19. *Freeman E.* Strategic Management: A Stakeholder Approach. — Pittman Books Ltd., 1984.
20. *Gordon M.*, *Shapiro E.* Capital Equipment Analysis: The Required Rate of Profit // Management Science. **3** (1): 102 — 110.
21. *Grant J.* Foundations of Economic Value Added. — New Hope, PA: Frank J. Fabozzi Associates, 1997.
22. *Jensen M.* Value Maximization, Stakeholder Theory, and the Corporate Objective Function // Journal of Applied Corporate Finance. 2001. **14** (3): 8 — 21.
23. *Lee C.* Measuring Wealth // CA Magazine.1996. **129** (3): 32 — 37.
24. *Lee C.* Accounting Based Valuation: Impact on Business Practices and Research // Accounting Horizons. 1999. **13**: 413 — 425.
25. *Lo K.*, *Lys T.* The Ohlson Model: Contribution to Valuation Theory, Limitations, and Empirical Applications // Journal of Accounting, Auditing and Finance. 2000. **15**: 337 — 360.
26. *Marshall A.* Principles of Economics. New York. 1890.
27. *McTaggart J.*, *Kontes P.*, *Mankins M.* The Value Imperative: Managing for Superior Shareholder Returns. – N.Y.: Free Press, 1994.
28. *Miller M.*, *Modigliani F.* Dividend Policy, Growth, and Valuation of Shares // Journal of Business. 1961. **34** (4): 411 — 433.
29. *Myers J.* Implementing Residual Income Valuation with Linear Information Dynamics // Accounting Review. 1999. **74**: 1 — 28.

30. *Ohlson J.* A Synthesis of Security Valuation Theory and the Role of Dividends, Cash Flows, and Earnings // Contemporary Accounting Research. 1990. **6** (2): 648 — 676.
31. *Ohlson J.* The Theory of Value and Earnings, and an Introduction to the Ball–Brown Analysis // Contemporary Accounting Research. 1991. **7** (1): 1 — 19.
32. *Ohlson J.* Earnings, Book Values, and Dividends in Security Valuation // Contemporary Accounting Research. 1995. **11** (2): 661 — 687.
33. *Ou J.*, *Penman S.* Financial Statement Analysis and the Prediction of Stock Returns // Journal of Accounting and Economics. 1989a. **11** (2): 295 — 329.
34. *Ou J.*, *Penman S.* Accounting Measurement, Price-Earnings Ratios, and the Information Content of Security Prices // Journal of Accounting Research. 1989b. Supplement **27** (3): 111 — 144.
35. *Penman S.* Return to Fundamentals // Journal of Accounting, Auditing & Finance. 1992. **7** (4): 465 — 484.
36. *Penman S.* A Synthesis of Equity Valuation Techniques and the Terminal Value Calculation for the Dividend Discount Model // Review of Accounting Studies. 1998. **2** (4): 303 — 323.
37. *Penman S.*, *Sougiannis T.* A Comparison of Dividend, Cash Flow, and Earnings Approaches to Equity Valuation // Contemporary Accounting Research. 1998. **15** (3): 343 — 383.
38. *Penman S.* Financial Statement Analysis and Security Valuation. — N.Y.: McGraw-Hill, 2001.
39. *Penman S.*, *Yehuda N.* The Pricing of Earnings and Cash Flows and the Valuation of Accrual Accounting. 2003. Working Paper. Columbia University, NY, USA.
40. *Richardson G.*, *Tinaikar S.* Accounting Based Valuation Models: What Have We Learned? // Accounting and Finance. 2004. **44**: 223 — 255.
41. *Sharpe W.*, *Alexander G.*, *Bailey J.* Investments. 5th ed. — Englewood Cliffs, NJ: Prentice Hall, 1995.
42. *Stewart B.* The Quest for Value: A Guide for Senior Managers. — N.Y.: Harper Business, 1999.
43. *Volkov D.* Models of fundamental equity valuation: the problem of compatibility // Vestnik (Herald) of St. Petersburg University. Series: Management. 2004a. (3): 3 — 36 (In Russian: *Волков Д.Л.* Модели оценки фундаментальной стоимости собственного капитала компании: проблема совместимости // Вестник

С.-Петербургского ун-та. Сер. Менеджмент. 2004a. (3): 3 — 36).

44. *Volkov D.* Value-based management and the problem of choice of the adequate valuation model // Vestnik (Herald) of St. Petersburg University. Series: Management. 2004b. (4): 79 — 98 (In Russian: *Волков Д.Л.* Управление стоимостью компаний и проблема выбора адекватной модели оценки // Вестник С.-Петербургского ун-та. Сер. Менеджмент. 2004b. (4): 79 — 98).
45. *Volkov D.* Performance metrics: use in value-based management // Russian Management Journal. 2005a. **3** (2): 3 — 42 (In Russian: *Волков Д.Л.* Показатели результатов деятельности: использование в управлении стоимостью компании // Российский журнал менеджмента. 2005a. **3** (2): 3 — 42).
46. *Volkov D.* Value-based management: metrics and valuation models // Russian Management Journal. 2005b. **3** (4): 67 — 76 (In Russian: *Волков Д.Л.* Управление ценностью: показатели и модели оценки // Российский журнал менеджмента. 2005b. **3** (4): 67 – 76).
47. *Volkov D.* Theory of Value-Based Management: Financial and Accounting Aspects — St.Petersburg: St.Petersburg University Publishing House, 2006 (In Russian: *Волков Д.Л.* Теория ценностно-ориентированного менеджмента: финансовый и бухгалтерский аспекты. — СПб.: Изд.дом С.-Петербургск.ун-та, 2006).
48. *Wallace J.* Value Maximization and Stakeholder Theory: Compatible or Not? // Journal of Applied Corporate Finance. 2003. **15** (3): 120 — 127.
49. *Williams J.* The Theory of Investment Value. — Cambridge, MA: Harvard University Press, 1938.