The Impact of Cash Flows and Weighted Average Cost of Capital to Enterprise Value in the Oil and Gas Sector

Zhukov Pavel*

Moscow, Leningradsky pr. 49, Department of Corporate Finance and Corporate Management, Financial University under the Government of the Russian Federation, Russian Federation

Abstract: This paper investigates whether there is relationship between fluctuations of enterprise value or capitalization and related changes of WACC and cash flows. The study carried on the sample of some companies from the oil and gas sector, for the changes at intermediate term - from a quarter to three years. At the first stage the common model of discounting free cash flow on WACC was considered as the base model for research. The main conclusion was - intermediate term changes in the enterprise value are independent from changes of WACC. Dependence from changes in cash flows is either insignificant, except permanent growth rate for some growing companies. Finally it is concluded, that traditional WACC is not relevant discount rate for an assessment of enterprise value. At the second stage the alternative method for assessment of enterprise value was proposed, where cash flow is considered equal to expected value, which may grow with permanent growth rate. The method is based on stochastic cost of capital, similar to the generalized method of moments proposed by J. Cochrane, but different in conduction.

Keywords: Enterprise value, capitalization, financial risks, WACC, stochastic discount rates, generalized method of moments.

1. THE IMPACT OF CASH FLOWS AND RISKS ON THE ENTERPRISE VALUE - THEORETICAL AND EMPIRICAL REVIEW

MM theory and interrelated CAPM are widely and rightly considered as the basement of modern financial theory (see, for example, Pagano (2005)) and both have some different modern variations. There are several possible ways to prove MM theorems. However most of proofs usually follows original approach as it was proposed by Modigliani F. and Miller M. (1958), and later, in a corrected form by Modigliani F. and Miller M. (1963). So, commonly proofs of MM theorems are based on the impossibility of arbitration and, thus, assume financial markets as perfect, all-knowing and being always right. Especially controversial assumption is the impossibility of bankruptcy (going-on concern). Perhaps, the most simple and elegant proof can be found in the academic textbook (which is monograph in fact) by Tirole (2006) together with an extensive literature review on the development of the theory of MM and its empirical verification.

Stieglitz (1969) criticized MM theory stating five limitations of its proof, and particularly (at number five) that it was not clear how the possibility of bankruptcy affected validity of MM theorems. The possibility of bankruptcy was later posted in theory of compromise ("trade-off"), but this branch of the MM theory does not provide tools for calculating the cost of bankruptcy, it is considered as exogenous. Actually the MM authors did not consider the costs of bankruptcy (or financial distress) as a significant factor at all. So, the main direction for next MM researches has become tax effects accounting – see Miller M. (1988).

Many author are referring to the classical monograph by Donaldson (1969), where discussed various financial strategies used United States companies and many practical examples. Donaldson concludes that companies usually stick to permanent capital structure and if change it (which is done under circumstances only), then follows certain hierarchy of decisions. Later, his theory gets the name “pecking order theory”. Later Myers (1984), denying the materiality of bankruptcy costs, introduced a new direction in theory development – accounting for transaction costs, which may explain Donaldson’s empirical results.

Empirical check for both trade-off and pecking order theories in the view of capital structure was run by Fama and French (2002). As a result, the panel was obtained with conflicting conclusions, where some (3 conclusions) are rather in consent with the first theory, and some (another 3 conclusions) are rather in consent with the second one. So, judgment was made that both theories may be right (despite contradiction).

An alternative method of stochastic modeling was proposed by Strebulaev (2007). It was based on

*Address correspondence to this author at the Moscow, Academica Volgina ul., 23,1,200, Russian Federation; Tel: +7(985) 231-0361;
E-mail: paul-joukov@yandex.ru

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modelling a random change of enterprise value and then changing capital structure for better. That method of stochastic modeling largely is based on Merton's model for valuing bonds and default costs as an option. Strebulaev finds the contradiction between the theories of "compromise" (trade-off) and "hierarchy" (pecking order) is inconsequential in terms of modelling results. Thus, the conclusion was evolved that results of Fama and French (2001) are not so controversial as it seems and really both theories may be right.

Evidently, the limited lifetime of company may influence its WACC and the enterprise value comparing with a firm unlimited in time, as it supposed to be under the "going-concern" concept. That was initial idea for the theory of Brusov-Filatova-Orechova, proposed in Brusov P., Filatova T., Orehova N., Brusova N. (2011). It was based on optimizing the enterprise value with limited life, versus a model firm in the MM theory which was denoted as "perpetuity" firm. The Brusov-Filatova-Orechova theory proves that firm with a finite lifetime should observe abnormal effect: reducing the cost of capital with growth of leverage (see Brusov P., Filatova T., Eskindarov M., Orehova N., Brusova A. (2012)). In this theory there is no optimal capital structure neither in modified MM case (Brusov P., Filatova T., Orehova N. (2014a)) nor in the modified trade-off theory (Brusov P., Filatova T., Orehova N. (2014b)).

An alternative view on the corporate financial policy was exposed by Tirole (2006), where the central point is agency problem and related information asymmetry between the insiders (managers) and the outsiders (shareholders). That is certainly one of the main sources of market imperfectness, and so one of the central problems for the corporate finance. The agent problem obviously may have an impact on the both costs of bankruptcy (or financial distress) and transaction costs. Monograph is based on the wide review of empirical results, and considers some contradictions between empirical results and financial theory. That goes well beyond of either MM or CAPM theories, even considering all the modernizations.

The original motivation for this work is the following question – how can MM theory explain real empirical middle-term changes in enterprise value? Similar questions are discussed in the numerous researches, mainly for the long term horizon and in the context of optimal capital structure (e.g. see Koller T., Goedhart, Wessels D.(2010), or . Pratt S., Grabowski R. (2008)).

There is well known (e.g. Cochrane (2005)), that in a very short term periods (like days or weeks) price movement conforms to random walk (or martingale). Also there is empirically justified growth in long term returns on stocks and indexes which are still different for different periods. However, that is not clear for middle term return or price dynamics, and there are not much works on this matter.

So for middle-term horizon - from one quarter to three years it is not so clear and may still be a puzzle. The middle term may conforms to typical investment horizon for many investors and it may be supported by maximal samples of data, available in "Bloomberg" about such variables as WACC, FCF, CFO, M-cap and etc. for the period 2000-2017.

The common identity for the enterprise value (may be taken as definition) is:

$$EV = MV (Eq) + MV (ND) \quad (1)$$

Second term represents the market value of the net debt and usually it is the difference between gross debt and liquid assets - cash and market securities.

$$MV (ND) = MV (D) – Cash - MS \quad (2)$$

Of investor rationality postulate can be deduced that the total enterprise value is equal to the discounted value of the free cash flows to the company:

$$EV (0) = \sum_{t=1}^{\infty} FCF(t). /(1 + CC (t))^t \quad (3)$$

Here FCF(t) - the expected future free cash flows to the firm, and CC(t) is the expected cost of capital.

Formally (3) also may be treated as identity, or an equation for either an unknown cash flows or for an unknown capital cost. However, as there is only one equation, one may use single average cash flow or single average capital cost or both.

MM theory in fact (albeit implicitly) used the postulate of a rational behavior of investor which create enterprise value (3) and it proves that the discount rate in (3) is equal to the weighted average cost of capital WACC, composed of required return (opportunity costs) on shareholders' equity and the required yield on debt, taken after tax shields:

$$WACC = Re* we + Rd *wd (1-T) \quad (4)$$

Here Re – required return for equity (commonly treated as a return to diversified portfolio with the same risk), Rd – cost of interest bearing long term debt, we and wd – shares of equity and debt in the enterprise

value, T – marginal rate of corporate income tax. As a rule of thumb, the weighted average cost of capital (4) is considered permanent in MM since as all variable factors (including individual risks) are reflected in the expected (or implied) free cash flows.

However, it may be noted that the expression (4) for the discount rate, combined with CAPM for Re assessment, is the most controversial part in MM theory, while the expression (3) can be taken as a mere definition, or identity.

In the work by Zhukov (2015) there is also offering an alternative variant for MM theory, including all bankruptcy (default, financial distress) costs, and transaction costs, covering both trade-off and pecking order theories. There is shown that the modified theory of MM (preserving the main results) can be built just on identities (3) and (4), added with an assumption that required yield on equity depends on the debt leverage as it follows directly from the effect of financial leverage. So, in fact, MM theory actually relies neither on market perfectness nor on impossibility of bankruptcy, as it is widely accepted, but just on (3) and (4) identities.

Also, given the company's value, the identity (3) can be understood as the equation for average discount rate given the cash flows or on the contrary, as the equation for average cash flow at specified discount rates. In particular, the works of Brusov and etc. (2011-2014) offers alternative methods for determining discount rates WACC(t) using given enterprise value, free cash flows and some of optimization techniques.

The company's cash flow (free cash flow) is usually defined as the cash available for distribution to investors and creditors after capital expenditures:

$$FCF(t) = CFO(t) - CAPEX(t) + Int(t)(1-T(t))$$

Here CFO(t) is net operating cash flow, CAPEX(t) - net investment in fixed capital, Int(t)-interest for the loan, and T(t)- the effective tax rate applicable.

Identity (3) is also widely used as justification for the company's valuation methods on discounted free cash flows or DCF (e.g. see Koller T., Goedhart, Wessels D. (2010)). Accordingly, both in theory and in practice, the central problem of the company value management is usually reduced to cash flow management, risk management or capital structure management.

Cochrane (2011) proved that the main role in the prices volatility plays discount rates volatility but not the volatility of cash flows. However, this result are of a fairly general nature and their applicability to individual companies and especially in a medium term is not clear, because the study was conducted for stock exchange indexes, and over a long period of time.

2. DESCRIPTION OF METHODS AND MODELS FOR RESEARCH-MODIFIED MODEL MM AND GENERALIZED METHOD OF MOMENTS

For the first phase of the study in this paper examines the enterprise value's dependence on cash flows and the weighted average price of capital resulting from the (3) and (4). Relative changes in values are stochastic processes of type TS (trend stationary) and are subject for the usual F -statistics (e.g. see Hamilton (1994) and Wooldridge (2002)). At the first stage, generally, results were negative. Main of which - enterprise value changes do not depend on changes of cash flows or WACC.

For the second phase the research used generalized method of moments proposed by Cochrane (2005). The term "generalized method of moments" and its idea comes from similar in form (but different in a purpose) general method for statistical evaluation of the best parameters of econometric models by Hansen (1982).

Cochrane's (2005) generalized method of moments originally summarizes approaches of the CCAPM (CAPM, ICAPM and etc.), since the method is based on the general concepts underlie utility function and reward from the asset (asset payoff). Use of stochastic discount factor seems quite logical in terms of macroeconomic equilibrium theory, based on a choice between the future and the present consumption. Similar ideas can be found in Tirole's (2006) monograph, which asserts that the entire MM theory may be obtained from the model of macroeconomic equilibrium (particularly Errow-Debre model). Cochrane (2005), also relates his model to the global equilibrium, but states particularly that it doesn't depend of any of its highly limiting assumptions. So, actually that model is not affiliated with CCAPM and there are stated some contradictions of CCAPM outcomes with practice (Cochrane (2005) call it "puzzles").

Generally one may choice between two alternative approaches – either to use stochastic cash flows but fixed discount rates (like in MM), or to run with fixed expected cash flows and stochastic discount rates (Cochrane (2005)). The reason for this duality is - any risk factors can be taken into account either in cash

flows or in discount rates and both approaches should theoretically lead to the same results. In the present work both methods are applied – first at the first stage and second at the second one.

At the first stage (most common way) it is assumed that investor at the time of the evaluation may not be willing to use any future required rates of return (which are impossible to predict), but rather tends to apply the current required rate of return at the time of assessment. In this case stochastic factors may be considered in expected cash flows. But at the second part of this work, on the contrary, the anticipated cash flows are specified as fixed with permanent growth rate and the discount rates are stochastic.

3. FIRST STAGE - ANALYSIS OF STOCHASTIC CHANGES IN THE ENTERPRISE VALUE BASED ON THE COMMON DCF MODEL, FREE CASH FLOWS AND WACC.

Under the assumption that free cash flow model (3) is underlying basis for enterprise value, one get the equation:

$$EV(t) = (FCF(t+1) + EV(t+1))/(1 + WACC(t))) \quad (5)$$

This also can be written in incremental form:

$$EV(t+1) - EV(t)(1 + WACC(t)) = -FCF(t+1) \quad (6)$$

Both equations may be extended from 1 period of time to any number of periods. So, (5) and (6) will be considered below as the model for increments from 1 quarter to 3 years.

At the first phase of the study the following issues were questioned:

1. Does the model (3) with discount rates WACC (4) really explain the fluctuations in the value for the selected sample of companies in the oil and gas sector?

2. More generally - how much the changes in enterprise value are related (or may be explained) to the changes in free cash flows and WACC?

3. May changes in the market capitalization of the company be explained with the changes in its enterprise value?

4. Would the results sustain if replace the free cash flows to the cash flows from operating activities plus interest?

It is easy to show that if a stochastic series (3) converges in the sense of mathematical expectation, its sum is equal to the expected enterprise value (e.g. see Wooldridge (2002)). Denote the actual cash flows through FCF*(t), expected cash flows through FCF(t) and zero-median stochastic fluctuation through δ (t):

$$FCF^*(t) = FCF(t) + \delta(t) \quad (7)$$

The expression (6) for the increase in the enterprise value becomes a deterministic when investors can precisely assess expected cash flows and discount rates in infinite limit. In that case one may observe correlation of actual enterprise values and those derived from (6) as equal to 1 and with the significance level close to zero (that forms hypothesis H1). However, if that correlation is equal to zero (which is hypothesis H0), one must assume that investors essentially changes their assessment of future risks and (or) cash flows for the every projection period.

The sample for the study was compounded from six of oil and gas sector companies - Lukoil, Rosneft, Gazprom, Novatek, BP, Dutch-Shell. But in order to identify the possible impact of a sample on the results, the company from the opposite sector (by systematic risks) was added - Coca Cola [1].

To answer the question 1 the validity of the model (3), (4) was examined on the changes in the enterprise value after 1, 2 and 3 years. The result was a conclusion that enterprise value increment for the periods from 1 to 3 years with probability from 35% to 86%, is not correlated with the theoretically expected increment calculated on the basis of free cash flows model (3) and (4). So, H0 hypothesis of zero correlation is most likely (or, at least, can't be rejected).

$$\text{Corr}\left(EV_{t+n}/(1+WACC(t+n))^{n} - EV_t,\ \sum_{\tau=1}^{n} FCF(t+\tau)/(1+WACC(t+\tau))^{\tau}\right) \sim 0$$

Thus, it turns out that the change in enterprise value for the period from 1 to 3 years is not dependent on its cash flows for the period, discounted at the WACC. That means that the common model (3), (4) doesn't work at the middle-term forecasting period. For the longer period it means that even if investors use (3), (4) for forecasting period, they permanently (every quarter or month) changes estimates for either the future

[1]Actually the sample included more companies from 4 industries, but for the brevity this work describes results for oil and gas sector, adding just one company outside it – Coca-Cola, for comparison.

expected cash flows, or the discount rates, or both together.

Question 2 is actually a generalization of question 1. Obviously, the cash flows reflect the benefits to investors and when there is a significant change in cash flows, investors must adjust their evaluation. This approach must be based on planned (forecasted) numbers, since the cash flows of the company usually can be anticipated for the year ahead-based financial planning.

In addition, there are numerous empirical studies confirming the intuitively obvious assumption that investors adjust prices depending on the news. And this news usually relate to either the future cash flows to the company, or to the macroeconomic risks. On the other hand, WACC reflects the systematic risks of the company (or at least pretend to do it). Accordingly, the change in the weighted average cost of capital should lead to a change in the company's value not only for model (3), (4), but also on the general basis of the hypothesis of rational expectations.

But answer to question 2 is negative - no dependency was observed for the selected sample. It can be assumed that this is true for the many other companies. A brief description of the results of the study is added in annex 1.

The relative increment of the enterprise value (in% to the previous) was chosen as the dependent (explained) variable, and as independent (explaining) variables there was chosen relative increments of free cash flow, net cash flows, or WACC. Note that since relative changes were chosen, this process must be TS-type with zero trend. Correlation values obtained during regression range from 0.13 to 0.01, but in any case the hypothesis H0 could not be rebutted with a minimally acceptable level of significance (10%), and for the most cases its probability is higher than 30%.

This result is surprising and even paradoxical, since it is generally assumed (see e.g. Koller T., Goedhart, Wessels D. (2010)), that investors adjusts their estimates of enterprise value either for a change in the cash flows of the company or in the risks. In addition, since the expression for WACC (4) reflects systematic risk, it turns out that the main role for the variability of enterprise value plays individual risks, on the contrary to any version of CAPM theory.

Answer to question 3, however, is positive - it was found that enterprise value and market capitalization has a strong interdependence for the oil and gas sector, which corresponds to the MM outcomes. Presumably, they are co-integrated, unless happens radical change in the capital structure or risks. But for the company from beverages sector (Coca-Cola) that result is negative. Probably this difference is caused by the stability of capital structure in oil and gas sector.

Answer to the question 4 for oil and gas sector is positive too - results for free cash flow and net cash flow of operating activities nearly coincides. This appears to be related to the relatively stable investment cash flows. However, for the company from beverages sector Coca-Cola again assessment gave negative result. This may be caused by relative stability of investments in the oil and gas sector which is not the case for fast growing companies (e.g. for Apple operating cash flow is fast increasing while free cash flow didn't change so much).

4. SECOND STAGE - CHECKING COCHRANE'S GENERALIZED METHOD OF MOMENTS

At the next stage changes of enterprise value were assumed as independent on cash flows and WACC. So, expected free cash flow was assumed determined, but growing linearly with time. Then stochastic discount rates absorb all the information of price changes. That assumption may be derived from two hypotheses:

1. Investor ignores random fluctuations in cash flows and instead uses some pre-determined value of the expected free cash flow.

2. Investor uses stochastic (randomly changing) discount rates reflecting either the stochastic risks or changes in the investor's expectations about the growth rate of cash flows in future.

With some basic (minimum) investment, the expected free cash flows of the company will have permanent expected value, but with additional investments free cash flows may grow. Denote FCFexp expected basic free cash flow:

$$FCFexp=E(FCF(t)) \quad (8)$$

In the case of zero growth one may find unique discount rate R from equation:

$$E\,(EV(t)) = EVexp = FCFexp/R\,(t) \quad (9)$$

With some additional investments free cash flows and enterprise value will grow with permanent growth rate g (t):

Table 1: Averages and Variability of WACC and Stochastic Discount Rates for BP Since 2000 by 2016. (According to Data from Bloomberg)

	WACC	CFO mln.$	FCF mln.$	Rcfo	Rfcf	EV mln.$	Mcap mln.$
Median	0.088	539	135	0.012	0.003	144000	111000
St . Var.	0.19	1.84	0.46	0.21	0.21	0, 27	0 , 38

$$EVexp\ (t) = FCFexp\ (t+1)/(R(t) - g\ (t)) \quad (10)$$

Assumption 1 means that investors may use some pre-determined value for expected free cash flow used in assessment, but for every period it changes assessments for required rate of return and (or) growth rate. So, it must affect enterprise value. Consequently, the discount rate is stochastic and time dependent, although investor at a time applies a single rate for future cash flows.

In zero-growth case (8) cash flows can be considered fixed and discount rates in (9) are stochastic. Then, for the general case with permanent growth rate the stochastic discount rates are:

$$r\ (t) = R\ (t)-g\ (t) = FCF\ (t+1)/EV\ (t) \quad (11)$$

Here R (t)-stochastic cost of capital, reflecting stochastic risks, and g(t) is an average growth rate for expected free cash flow at the minimal investments.

More generally, whatever the assessment methods is actually used by investors, their results can be summarized as the expected cash flow (FCF(t+1)) and a stochastic discount rate (r(t)).

Given the cost of capital equal to WACC from (11) one can find an appropriate growth rate. However, the results of the research shows that growth rate, derived from WACC, have no relation to the changes in the enterprise value, which makes its use pointless. Moreover, the mean value of WACC is much higher than empirically determined stochastic discount rates (see Table **1**). While it is important to note that the standard deviation of stochastic rates roughly equal to that of WACC.

So, consider the cost of capital as a stochastic variable is the best option, while the expected growth rate in this case should be assumed constant. This choice is optional in nature, since the evaluation of these variables can be changed by investors. However, since the only important variable is just difference between cost of capital and growth rate, there is no reason to use two stochastic variables and one may select any of them as stochastic.

CONCLUSIONS

1. Model (3), (4) (generalization of MM theory) does not explain the medium-term changes of enterprise value and that casts doubt on the possibility of using the DCF method (discounting on WACC free cash flow) to evaluate enterprise value in the long term run.

2. Changes of the WACC do not affect medium-term changes in the enterprise value or the capitalization for the selected sample of companies. So, use the WACC calculated in line with the theories of MM and CAPM (or CCAPM), as a discount rate for the free cash flow gives no results comparable with empirical data for selected sample of the companies in medium-term assessment.

3. As changes of WACC reflect changes in systematic risk, it may be assumed that individual risks (which are not reflected in WACC) provide a major influence on medium-term changes in the enterprise value.

4. Medium-term changes in free cash flows do not affect changes to the enterprise value of the companies from selected sample (except Coca-Cola and some fast growing companies). It may be assumed that to assess the enterprise value of company one may use a long-term cash flow value, growing with permanent growth rate (may be positive, zero or negative) and stochastic discount rates.

5. Cochrane's idea of prevailing role of variability in discount rates over variability of market prices is valid not only in relation to the larger indexes (see Cochrane (2011)), but also for individual companies. Thus, the Cochrane's model of generalized moments can be used to evaluate a company's prices instead of models with fixed discount rates and stochastic cash flows, like (3), (4).

APPENDIX 1. CHECKING THE INDEPENDENCE OF PRICE CHANGES FROM THE CHANGE OF THE COMPANY'S CASH FLOW (FCF, CFO) AND THE DISCOUNT RATE (WACC)

Because the company's value changes constantly in real time, it can be interpreted as a realization of a stochastic process. Changes in the prices of shares in companies usually are of type DS (difference stationary) and to examine them usually there are used autoregressive models (AR), or combined with MA (moving average) process - ARIMA models. In the present work subject of research is the dependence of relative change of enterprise value from the relative change in cash flows and WACC. The percentage change in asset prices refers to processes of type TS (trend stationary) with zero trend and, therefore, results may be assessed with applicable F-statistics. For the percentage change in the enterprise value it is:

d EV (t) = (EV(t)-EV(t-1))/EV (t)

Independent variables were changes the discount rate WACC, free cash flow FCF (4) and operating cash flows adjusted for interest payments (10):

d WACC (t) = (WACC (t)- WACC (t-1))/WACC (t)

d CFO (t) = ((CFO (t)-CFO (t-1))/CFO (t)

d FCF (t) = ((FCF (t)- FCF (t-1))/FCF (t)

For example, for the Corporation BP the chance of hypothesis H0 is over 84%. The only variable which tends to show a sustained and significant correlation with the enterprise value (and with correlation coefficient close to one) is market capitalization. This conclusion is consistent with MM. However, this conclusion is not trivial, given that in expressions (2) and (3) all variables may change significantly over time. Moreover, for the one company from the sample, Coca Cola, this conclusion turned out to incorrect - change in enterprise value was not associated with changes in capitalization. The reason for this is not clear, but it is clear that this company proved an exception to the general rule (probably due to the nature of its financial policy).

Also for this company there is significant dependence of the change in market capitalization and free cash flow changes (for other companies it is not).

According full price company (probability of the hypothesis H0 and R^2)

Company	FCF (p-val.)	CFO (p-val.)	WACC (p-val.)	R^2	F-stat (p-val.)	MCAP (p-val.)	R^2 for the Mcap
BP	0 , 64	0.6	0.78	0.01	0.89	10E-57	0.97
Shell	0.3 5	0.38	0.5	0.1 3	0.0 7	-33 1.57	0.94
Coca-cola	0.6 1	0.65	0.95	0.01	0.97	0.9 8	1, 6E-05
Rosneft	0.63	0.3 2	0.1 4	0.07	0, 4	2, 6E-27	0.9 4
Lukoil	0.3 1	0.7 1	0, 4	0.02	0.68	5, 1E-45	0.96
Gazprom	0.85	0.24	0.38	0.07	0.23	2, 62E-27	0.9 4

Thus, there are no observed significant dependencies of changes in enterprise value from changes to FCF, CFO and WACC. On the contrary, it is very likely that estimated correlation coefficient is indistinguishable from zero.

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