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Revisiting WACC

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Abstract - The paper compares classic WACC valuation method with equity cash flow and capital cash flow methods. As WACC method always use market values of debt and equity to determine weights, the method can give erroneous results whenever there are mismatches in the market valuation of debt. The tax-shield benefits are related to the actual interest amount that is based on the book value and therefore, the WACC computation method need to account tax shield benefits using book values. The paper used an example to compare valuation of a project using various valuation methods and found that the net present value obtained using modified version of the WACC, that used book value of debt to account tax shield, was comparable to other methods.

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I. Introduction

To assess the value of a project or business, a number of cash flow valuation methods are used. The most common method to value the business is to determine free cash flow to the business and discount the cash flows by weighted average cost of capital (WACC). Though the method is quite popular and used since mid of last century, the method do not accurately measure effects of interest tax shields benefits whenever market value of debt differs substantially from its book value and therefore valuing of a project using the classic WACC method is not always correct. This distortion is apparent when the same project is valued using other valuation methods.

The accuracy of ascertaining discounting rate is important as a small change in this single estimate alters the Net present Value (NPV) measure of the project in a significant manner. The use of classic WACC formula may often present an optimistic NPV and consequently lead to a wrong investment decision. In this paper the WACC method of valuing cash flows is compared with the method of valuing a project from cash flow accruing to equity holders and capital cash flow (CCF) method proposed by Rubeck (2002). It was found that a minor adjustment in WACC computation method will make valuation using all the methods identical.

II. WACC

From the seminal contribution of Modigliani and Miller (1958), finance theory has accepted that a project's cash-flows should be discounted at a rate that reflects the project's risk characteristics. Whenever a company's equity structure consists of both equity and debt, the appropriate discounting rate is weighted average cost of capital (WACC).

WACC method is the most popular approach used to value a project by discounting its unlevered cash flows using a weighted average after tax cost of capital. It is assumed that the project is fully financed by equity and therefore tax liability is estimated on earning before interest payment. The net asset value (NPV) for a constant perpetual cash flow of the project is measured as follows:

$$NPV = \sum_{t=1}^{n} \frac{FCF_t}{(1+r_{wacc})^t} - I$$

Where FCF is free cash flow, I is the initial investment from the project and rwacc is the weighted average cost of capital.

When the project is financed with both debt and equity, the interest expense qualifies for tax exemption and reduces effective cost of debt. The benefit of tax shield is incorporated in the discounting rate by multiplying a factor (1-tax rate) to the cost debt. The effective cost of debt after tax is thus reduced to account for tax benefit available for interest expense. The usual formula to estimate WACC is given below:

$$r_{wacc} = \frac{E_{mv}.r_e + D_{mv}.(1-T).r_d}{E_{mv} + D_{mv}}$$

Where :

r_{wacc} = weighted average cost of capital
E_{mv} = market value of equity
D_{mv} = market value of debt
r_e = cost of equity capital
r_d = cost of debt capital
T = tax rate

According to the formula, the weighted average cost of capital embodies the relative proportion of debt and equity supplied by investors at the respective required rates of return. The cost of debt capital depends on a company's outstanding interest bearing debt. Since interest expense qualifies for a tax deduction, the formula captures the cost of debt at the company's effective tax rate. The WACC approach incorporates all financing considerations in a single discount rate and simplifies decision making.

In the formula, market values of equity and debt are taken instead of their book values. The market value of the company's equity can be obtained from stock price quotes. The market value of debt capital can be estimated by considering cash flow accruing to debt holders and the market interest rate.

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III. Cash Flow Measures

In the paper following three cash flow estimates are discussed:

- Free Cash Flow
- Cash flow to Equity
- Capital Cash Flows

a) Free Cash Flow

The value of a business is equal to the discounted value of future cash flows. The free cash flows (FCF) to the business equal the cash flow generated by the project during its life less capital invested in the business. The free cash flow of the firm includes the cash flows available to all investors – equity holders and bond holders. Thus free cash flow is independent of capital structure of the business.

The simplest route to measure free cash flow to the firm is to use information available in the income statement of the firm. From the earning before interest and tax (EBIT) the non cash expense of depreciation is added, taxes are deducted and net cash flows on account of new investments in assets and working capital are also deducted.

FCF = EBIT (1 - tax rate) + Depreciation - Capital Expenditure - Δ Working Capital

In the above formula, payments to debt holders are not considered; therefore the estimate is a measure of for unlevered cash flow. Since leverage is not accounted, the tax benefits because of interest payments are also excluded. It is therefore necessary to consider the tax benefits on interest tax shields in the discounting rate.

The discount rate for FCF need to represent rates of return required by both equity holders and bond holders blended together. It is a single estimate of opportunity cost of capital for the whole business.

b) Capital Cash Flows

In capital cash flow (CCF) method, the cash flow includes the cash available to all capital providers, including the interest tax shields. The interest tax shields decrease taxable income; decrease taxes and thereby increase after-tax cash flows. Thus capital cash flows is equal to the total cash flows available to both equity holders and bond holders including interest tax shield benefits accruing to equity holders.

Capital Cash Flow = Free Cash Flow + Interest Tax Shield

Since tax shield benefits are included in the cash flow estimates, the taxes are not again counted in the denominator. The discount rate to value Capital Cash Flows (CCF) is a before-tax weighted average rate.

$$r_{ccf} = \frac{E_{mv}.r_e + D_{mv}.r_d}{E_{mv} + D_{mv}}$$

Where :

r_{ccf} = weighted average cost of capital
E_{mv} = market value of equity
D_{mv} = market value of debt
r_e = cost of equity capital
r_d = cost of debt capital

The Free Cash Flow and Capital Cash Flow methods treat interest tax shields differently. In the first method, the tax shield is considered in the discounting rate rwacc and in the second case it is included in the cash flow. As per Ruback (2002), when debt is forecasted in dollar amounts or when capital structure changes over time, the CCF method is easier to use as the interest tax shields are a part of the cash flows. In the method, the expected return from the asset depends on the risk involved in the asset and therefore it is independent of changes in the capital structure. Consequently, the discount rate for the capital cash flows need not be re-estimated every period.

Ruback (2002) also showed that under certain assumption, the before tax WACC depends only on the market-wide parameters for the risk-free rate, the risk premium and on the unlevered asset beta.

$$r_{wacc(before\,tax)} = r_{risk\ free} + \beta_{unlevered} R_p$$

Where R_p is the risk premium and $\beta_{unlevered}$ is unlevered asset beta of the firm.

In the formula the market values of equity and debt are not required for estimating the discounting rate. This reduces the complexity of estimating WACC for every period.

Though Ruback's method of measuring discount rate apparently does not depend on capital structure of the company and need not be estimated afresh as capital structure changes, the main implementation problem is to find out future values of risk premium.

c) Cash flow to Equity

In some instances financial cash flow statements are prepared from two points of view:

1. The total investment point of view and
2. The owner's point of view.

The WACC and CCF method values the project from total investment point of view. However, it is also sometimes useful to analyze a project by constructing the cash flow statements from different points of view to establish whether the parties involved will find it worthwhile to execute the project. Cash flow to equity method value the business from the perspective of equity holders claims in the cash flows. cash flow to the firm measures the cash flow available to all investors but

cash flow to equity is a measure to find out what is left over (the residual) for the equity holders. It estimates the residual cash flow available to equity holders of the firm after payments were made to other stakeholders.

Cash Flow to Equity = Free Cash Flow – Interest and Debt Repayments

In the method, the suitable discount rate is shareholders required rate of return (r_e) and not r_{wacc}.

IV. Problems Associated with Wacc

According to theory, companies should value a project using a discount rate determined by the risk characteristics of the project. Discounting the cash flows at the firm's weighted average cost of capital (WACC) is the most popular but the method is sometimes inappropriate if the project differs in terms of its risk-ness from the rest of the firm's assets. Thus WACC need to be calculated separately for each project. A survey carried out by Bierman (1993) in the top 100 firms of the Fortune 500 found that 93% of the responding firms use a constant company-wide WACC to value projects and only 35% used division-level discount rates. Graham and Harvey (2001) reported that a large majority of firms use a common company-wide discount rate to value a project independently of the risk characteristics of the project. Another survey carried out by Kruger et al (2011) found that performing capital-budgeting using a unique firm-level WACC is common.

Additionally, risks involved in project cash flows are not always amenable to be measured with a constant discounting rate. The discounting rate r_{wacc} changes when debt to equity ratio of the firm changes on year to year basis. Miles & Ezzel (1980) showed that the WACC will yield correct valuations if the leverage ratio of the firm remains constant through time. WACC method is suitable as long as the firm maintains a constant leverage ratio. For project that need subsequent additional investment in future, maintaining constant debt to equity ratio is difficult.

In WACC, the values of equity and debt are taken in terms of market values, not at their book values. As market values of both equity and debt constantly changes, the WACC measure also changes with change in market perceptions. In many instances, the cash flows are discounted at a constant WACC and all such cases the implicit assumption is that the leverage of the business remains constant throughout the evaluation period. But the assumption is erroneous as maintaining constant debt equity ratio based on market value is not practicable. The WACC must be adjusted in every period to accommodate change in capital structure on market value.

Further, the measure provides little guidance when tax structure also changes with time.

Should WACC be always measured on market Value?

While estimating discounting rates for WACC and CCF methods, market values of equity and debt are used. In case of rwacc interest tax shields are incorporated in the discount rate in terms of market value of debt by application of the factor . On the other hand, the actual interest tax shield benefit is linked to actual interest paid that is related to the book value of debt. Thus interest tax shield need to be measured on book value and not on market value of debt. Whenever there is a valuation mismatch between book value and market value of debt, it is better to use book value of debt as interest tax shield is related to book value and not on market value. Fernandez (2003, 2010) argued that the WACC is the rate at which the Free Cash Flows need to be discounted for obtaining the identical result as in the valuation using Equity Cash Flows.

To obtain identical valuation using rwacc the formula to estimate the discounting rate need to be modified as follows:

$$r_{wacc(modified)} = \frac{E_{mv} r_e + D_{mv} r_{debt} - D_{bv}.r_{actual}.T}{E_{mv} + D_{mv}}$$

E_{mv} and D_{mv} are market values of debt and equity, D_{bv} is the book value of debt and r_{actual} is the interest rate payable on outstanding debt.

V. Valuation Example

So far three methods using free cash flows, capital cash flows and equity cash flows are discussed and all methods are found intuitively appealing! Let's now compare valuation using a simple numerical example.

The projected balance sheets and income statements of a hypothetical firm are given in table 1 and 2. The firm made an initial equity investment of $5500 at the beginning of the project and all incremental investment in the business was raised from additional debt. The projected income statements gave estimates for the initial five years and it was assumed that the cash flows after the initial five years would grow at 5% per year for perpetuity.

Table 1 : Projected Balance Sheet

Year	0	1	2	3	4	5
Equity	5500	5500	5500	5500	5500	5500
Debt	5500	5775	6050	6325	6600	6875
Total Liabilities	11000	11275	11550	11825	12100	12375
Gross Fixed Assets	8250	9900	11550	13200	14850	16500
Less Accumulated Depreciation	0	1650	3300	4950	6600	8250
Net Fixed Assets	8250	8250	8250	8250	8250	8250
Working Capital	2750	3025	3300	3575	3850	4125
Total Assets	11000	11275	11550	11825	12100	12375

Table 2 : Projected Income Statement

Year		1	2	3	4	5
Revenue		10000	15000	17500	20000	22500
Expenses		-8000	-12000	-14000	-16000	-18000
EBITDA		2000	3000	3500	4000	4500
Interest Payments		440	462	484	506	528
Depreciation		1650	1650	1650	1650	1650
Profit Before Tax		-90	888	1366	1844	2322
Tax		-31.5	310.8	478.1	645.4	812.7
Profit After Tax		-58.5	577.2	887.9	1198.6	1509.3

a) Cash Flow Statements

The following cash flow estimates were made.

- Free Cash Flow
- Equity Cash Flow
- Debt Cash Flow
- Capital Cash Flow

To arrive at free cash flow estimates, the PAT (unlevered) was calculated assuming no debt in the capital structure. From PAT (unlevered) depreciation is added back, additional investment in working capital and fixed assets are deducted. Equity cash flows were estimated considering actual leverage in capital structure. It was estimated from PAT adding depreciation and deducting additional investments.

Debt cash flow measures represented cash flows accrued to debt holders both in form of interest income and change in the principal component of debt. Whenever new debt was added to the capital of a firm, cash flows in hands of debt holders reduced. Capital cash flow was measured adding cash flows accrued to both shareholders and bond holders.

Table 3 : Cash Flow Statements

Free Cash Flow (FCF)

Year		1	2	3	4	5
EBITDA		2000	3000	3500	4000	4500
less depreciation		-1650	-1650	-1650	-1650	-1650
EBIT		350	1350	1850	2350	2850
Tax @40%		122.5	472.5	647.5	822.5	997.5
PAT (unlevered)		227.5	877.5	1202.5	1527.5	1852.5
add Depreciation		1650	1650	1650	1650	1650

less increase in WC		-275	-275	-275	-275	-275
less increase in Gross Fixed Assets		-1650	-1650	-1650	-1650	-1650
FCF		-47.5	602.5	927.5	1252.5	1577.5

Equity Cash Flow (ECF)

Year		1	2	3	4	5
Profit After Tax		-58.5	577.2	887.9	1198.6	1509.3
add Depreciation		1650	1650	1650	1650	1650
add increase in Debt		275	275	275	275	275
less increase in WC		-275	-275	-275	-275	-275
less increase in Gross Fixed Assets		-1650	-1650	-1650	-1650	-1650
ECF		-58.5	577.2	887.9	1198.6	1509.3

Debt Cash Flow (DCF)

Year		1	2	3	4	5
Interest Payments		440	462	484	506	528
less increase in Debt		-275	-275	-275	-275	-275
DCF		165	187	209	231	253

Capital Cash Flow (CCF)

Year		1	2	3	4	5
ECF		-58.5	577.2	887.9	1198.6	1509.3
DCF		165	187	209	231	253
CCF		106.5	764.2	1096.9	1429.6	1762.3

VI. Valuation of The Project

After ascertaining cash flows of the project in hands of different types of investors, the valuation of the project was done using following discounting rates.

Table	Cash Flow	Discounting Rate	Value
Table 4	Debt cash flow	Cost of debt	Market value of debt
Table 5	Equity cash flow	Cost of equity	Market value of equity
Table 6	Capital cash flow	WACC (before-tax)	Market value of project/firm
Table 7	Free cash flow	WACC (after-tax)	Market value of project/firm

Table 4 : Valuation of Debt Cash Flow

Year	0	1	2	3	4	5
Debt Cash Flow		165.00	187.00	209.00	231.00	253.00
r_d		8.00%	8.00%	8.00%	8.00%	8.00%
Value of Debt	6848	7230	7622	8023	8433	8855

Table 5 : Valuation using Equity Cash Flow

Year	0	1	2	3	4	5
ECF		-58.50	577.20	887.90	1198.60	1509.30
r_e	0	18.89%	18.40%	18.20%	18.07%	18.01%
Value of Equity	7408	8866	9920	10837	11597	12177
Debt	6848	7230	7622	8023	8433	8855
Value of Business	14256	16096	17542	18860	20031	21032

Table 6 : Valuation using CCF

Year	0	1	2	3	4	5
CCF		106.50	764.20	1096.90	1429.60	1762.30
WACC (before tax)		13.66%	13.73%	13.77%	13.79%	13.80%
Value of Business	14256	16096	17542	18860	20031	21032
Debt	6848	7230	7622	8023	8433	8855
Value of Equity	7408	8866	9920	10837	11597	12177

Table 7 : Valuation using Free Cash Flow / WACC

Year	0	1	2	3	4	5
ECF		-47.50	602.50	927.50	1252.50	1577.50
WACC (after tax)		12.31%	12.47%	12.55%	12.60%	12.62%
Value of Firm	14803	16673	18150	19501	20704	21740
Debt	6848	7230	7622	8023	8433	8855
Value of Equity	7956	9443	10529	11478	12271	12885

It was observed from table 7 that valuation using WACC (after tax) gave a different project valuation in comparison to other methods. To alleviate the difference of valuation using WACC (after tax) method, WACC (modified) was estimated using book values of debt and revised project valuation was given in table 8.

Table 8 : Valuation using Free Cash Flow / WACC(modified)

Year	0	1	2	3	4	5
ECF		-47.50	602.50	927.50	1252.50	1577.50
WACC (modified)		12.58%	12.73%	12.80%	12.85%	12.88%
Value of Firm	14256	16096	17542	18860	20031	21032
Debt	6848	7230	7622	8023	8433	8855
Value of Equity	7408	8866	9920	10837	11597	12177

When WACC modified values are used, all the methods gave identical valuation.

VII. Conclusion

To value a business or project the post popular method is to use WACC as discounting rate. In its basic definition, WACC is the weighted average of the cost of capital coming from both the equity and the debt. However, the practical implementation of WACC concept often poses problem due to changing leverage of the firm and tax shield valuations linked to the divergence between book values and market values. In this paper disparity due to tax shield valuation when market valuation of firm's debt differs from its book value is addressed.

The net present value of a project using other methods was compared with the valuation using WACC method. It was observed that value of the project using WACC (modified) accounted tax shield benefits more accurately and produced result that were comparable to

the results obtained from equity cash flow and capital cash flow methods.

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