

The superiority of FCFF over EVA and FCFE in capital budgeting

Paweł Mielcarz^{a*} and Franjo Mlinarič^b

^a*Department of Finance, Kozminski University, Jagiellonska 57/59, 03-301 Warsaw, Poland;*

^b*Faculty of Economics and Business, University of Maribor, Razlagova 14, 2000 Maribor, Slovenia*

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Misapplication and misinterpretation of capital budgeting techniques can lead to serious capital allocation and capital structure problems. Mainstream literature suggests at least ten approaches for free cash flow and discount rate estimation (leading to the same net present value – NPV) but their benefits vary a lot. We emphasise the application risks when using these techniques without considering the cost of capital for the whole company, thus leading to value decreasing investment decisions. A comparative analysis with a classical free cash flow to equity (FCFE) and economic value added (EVA) methodology will make a strong case for free cash flow to firm (FCFF) as the most efficient approach. We also shed additional light on the main risks associated with the FCFE technique and project-based weighted average cost of capital (WACC) in the capital budgeting process.

Keywords: capital budgeting; valuation; FCFF; FCFE; EVA; project WACC

JEL classification: G12, G31, G32

1. Introduction

Despite ample literature and practical cases on capital budgeting issues, we still witness some important methodological problems in most commonly used approaches. To overcome these issues, we try to deliver just the most necessary theoretical knowledge and apply it to demonstrate which mainstream capital budgeting approach (FCFF, FCFE or EVA) should be deemed superior. Our criteria demand alignment with company's goals, high operational clarity in internal and external information processes and low risk of manipulation or misinterpretation by different stakeholders.

Modigliani and Miller (1958, 1963) finished their seminal work on capital structure irrelevance (for firm value) with a clear warning about drastic simplifications they had to use '...in order to come to grips with capital structure problem'. Moreover, they invited everybody willing to contribute '...in the direction of greater realism and relevance' (Modigliani & Miller, 1958, 1963). A number of authors answered their call to complete a theoretical mosaic of market imperfections such as agency costs based on information asymmetry (Jensen & Meckling, 1976), credit rationing by banks (Jaffee & Modigliani, 1969) and bankruptcy costs (Warner, 1977). New theoretical ground gave rise to two leading capital structure theories: pecking order theory (POT) and trade-off theory (TOT). They were supposed to help estimate a crucial

*Corresponding author. Email: pmielcarz@kozminski.edu.pl

point for value maximisation (optimal debt/equity) and illuminate key information asymmetry risks for any investment.

The POT was introduced by Donaldson (1961) and popularised by Myers and Majluf (1984). It is based on an old-fashioned framework where internal financing is favoured over external financing. POT uses a semi-strong capital market efficiency hypothesis that helps explain how different forms of information asymmetry influence capital structure and thus a firm's valuation. Its main idea is based on signalling effects; therefore it doesn't suggest any optimal target debt/equity ratio.

Kraus and Litzenberger (1973) as well as Scott (1977) are credited with initiating the TOT. In their understanding, an optimal level of debt (capital structure) can be achieved when the marginal cost of debt (financial distress) equals marginal benefits (tax shield effect and lower agency problems). Further research by Jensen (1984), Harris and Raviv (1991) and Stulz (1991) exposed many forms of agency conflict costs, such as managerial perquisites, over- and under-investment problems, monitoring costs and delayed divestment problems.

Helped by portfolio theory (Markowitz, 1952) and especially by a useful tool, the capital asset pricing model (CAPM) provided by Sharpe (1963, 1964) and Lintner (1965), practitioners were enabled to estimate the cost of capital and thus equity value in a comprehensive way. Armed with all the building blocks for net present value (NPV) calculation, they needed some time until the 1980s when Pike and Sharp (1989) reported a substantial increase in NPV and internal rate of return (IRR) usage in US and UK companies.

However, we have to emphasise that only the big companies and diversified equity owners qualify for most of the assumptions in such models. Additionally, plenty of research work shows that the well-known capital budgeting methodology (ever since Fisher, 1930, and Williams, 1938) is often applied improperly. Drury and Tayles (1997) pointed out frequent misapplications due to the treatment of inflation and project risks with advanced manufacturing technologies (compare Ashford, Dyson, & Hodges, 1988; Bis, 2009; Burns & Walker, 2009), causing an under-investment problem. Fernandez and Bilan (2007) catalogued 110 errors clustered in six categories concerning company valuations. Additionally, studies from Graham and Harvey (2001), Pinegar and Wilbricht (1989) and Danielson and Scott (2006) found that smaller companies (under 250 employees) frequently use less sophisticated methods (payback period and accounting rate of return) than recommended by capital budgeting theory.

Based on the described circumstances and our practical experience with valuing dozens of SMEs and investment projects from various industries, we focused our research on the most efficient, comprehensible and informative NPV calculation technique to support value-based management decisions.

Literature on the subject (Fernandez, 2007a, 2007b) lists ten techniques for free cash flow and discount rate calculations that should lead to an identical NPV, provided the techniques are applied correctly. These techniques include both calculations based on future free cash flows, as well as on estimates of future economic value added. According to the practice of financial analyses and the popularisation of particular techniques in the literature, three techniques can be recognised as the most essential: discounted free cash flow for firm (FCFF), discounted free cash flow for equity (FCFE) and discounted economic value added (EVA). These approaches are often described as 'alternatives' because they lead to the same result in NPV calculation. However, the interchangeability assumption often leads to the wrong conclusion that one can use any of them to estimate the impact of the analysed project on the value of the whole

company. We are faced with a contradiction when correctly applied techniques give the same NPV value, but still can lead to value decreasing decisions.

In section 2, we present the three most common valuation approaches as well as a short numerical example to demonstrate optimal conditions for harmonising final results and we prepare the ground for further discussion. Section 3 elaborates the risk found in FCFE application and suggests a solution by taking into account the relation between the applied technique, cost of capital and capital structure theory. In Section 4, we discuss the risks of using project WACC instead of company WACC. The final section is dedicated to discussion and summary of our major findings.

2. Alternative valuation approaches: FCFF, FCFE and EVA

In corporate practice, the FCFF technique is most commonly used. It allows the analysis to be performed from the point of view of all parties financing the project. In this case, the interest from external capital is not taken into account, because external financing costs are included in the required rate of return on investment (represented by WACC). Including the interest on debt into the cash flow would lead to a double counting mistake, thus unreasonably lowering the value of NPV. Moreover, all capital expenditures are taken into account (with a minus) at the moment of their appearance. Financial charges resulting from the use of external capital constitute tax deductible expenses. Therefore, excluding the interest from the calculation of FCFF leads to an increase in income tax. The issue is solved by including a tax shield into the discount rate represented by WACC (Cegłowski & Mielcarz, 2001).

$$FCFF = EBT(1 - T) + A - WCI - I + RV_{FCFF} \quad (1)$$

where EBIT = earnings before interest and taxes, T = tax rate, A = amortisation, WCI = working capital investment, I = capital expenditure and RV_{FCFF} = residual value for all financing parties.

Using the FCFE technique, the cash flows and the required rate of return are calculated from the equity owner's perspective. This fact demands inclusion of interest on external capital in the free cash flow calculation and the use of cost of equity. The FCFE considers only expenditures from the investor's own resources and the repayments of debt when the instalments are due. From the technical point of view, the initial investments can be treated as total investment expenditures with the deduction of loans. From the investor's point of view, acquiring additional loans provides an inflow of funds, so it is marked with a plus. This technique also assumes that free cash flows generated by a given investment are to be discounted by the rate of return on investment required by the investor.

$$FCFE = PBT(1 - T) + A - WCI - I + D_N - D_R + RV_{FCFE} \quad (2)$$

where PBT = profit before tax, D_N = debts incurred, D_R = debt repaid and RV_{FCFE} = residual value for equity holders. There is the second technique of FCFE calculation that is based on FCFF recalculation:

$$FCFE = FCFF + D_N - D_R + Int \times (1 - T) + RV_{FCFE} \quad (3)$$

where Int = financial costs.

NPV calculation can be also based on the discounted Economic Value Added (EVA) technique.¹ Expected EVA in particular periods is derived from net operating profit after tax (NOPAT) reduced by the cost of capital (WACC) incurred on capital invested in the previous period. Similar to FCFF and FCFE techniques, the EVA technique requires adding the residual value in the last period, calculated according to the concept of EVA (RV_{EVA}). This value represents the difference between the market value of liquidated assets and the value of capital in the final investment period (CI_n). According to the basic assumption of the EVA concept, the project does not generate, nor decrease the value for shareholders in a given period when obtained EVA equals 0.

Capital invested at the end of period:

$$CI_t = CI_{t-1} - A + I + D_{WCI} \quad (4)$$

Economic value added:

$$EVA_t = NOPAT_t - WACC \times CI_{t-1} \quad (5)$$

The process of NPV harmonisation using three different techniques presented in Table 1 will be demonstrated in the following example presented in Table 2.

Table 1. Main differences in most popular NPV calculation techniques.

	Calculation perspective	Capital expenditure treatment	Flow / income (FCF/EVA)	Discount rate
FCFF	All financing parties view	Total, regardless of the financing source (bank/owner)	Debt financing operations (incurred loans, repayment and interests) are excluded	Weighted average cost of capital (WACC)
FCFE	Equity capital view	Exclusively investor's equity funds	Incurred loans increase, but repayment and interest decrease FCF for the owner	Rate of return expected only by the owner (cost of equity- r_e)
EVA	All financing parties view	Not applicable in EVA calculation	Calculation of income surplus over the cost of invested capital	Weighted average cost of capital (WACC)

Source: Compiled by the authors.

Table 2. Basic forecast data for Example 1.

Period		0	1	2	3
Operating profit	EBIT		1000.0	1100.0	1200.0
Tax rate	T	19%			
Capital expenditures	I	2100.0			
Amortisation	A		700.0	700.0	700.0
Working capital investment	WCI		20.0	30.0	40.0
Residual value for all financing parties	RV_{FCFF}				300.0
Share of debt in the capital structure	U_d	0.4	0.4	0.4	0.4
Share of equity in the capital structure	U_e	0.6	0.6	0.6	0.6
Cost of debt	r_d		8%	8%	8%
Cost of equity	r_e		12%	12%	12%

Note: Capital structure items are based on market values.

Source: Authors' calculation.

Table 3. NPV and IRR calculation based on FCFF technique for Example 1.

Period		0	1	2	3	
	Operating profit	EBIT	1000.0	1100.0	1200.0	
-	Tax*	Tax*	190.0	209.0	228.0	
=	Net operating profit after tax	NOPAT	810.0	891.0	972.0	
+	Amortisation	<i>A</i>	700.0	700.0	700.0	
-	Working capital investment	WCI	20.0	30.0	30.0	
-	Capital expenditures	<i>I</i>	2100.0	0.0	0.0	
+	Residual value for all financing parties	RV_{FCFF}			300.0	
=	Free flow for all parties	FCFF	-2100.0	1490.0	1561.0	1942.0
	Discounted FCFF (D FCFF)		-2100.0	1357.1	1295.0	1467.4
	NPV					2019.4
	IRR					56.3%

Source: Authors' calculation.

Free cash flow to firm (FCFF)

According to the generally accepted WACC formula, the cost of capital is equal to 9.79% for each estimation period. Using basic forecast data and the calculation algorithm for FCFF, we present the results for NPV and IRR from the perspective of all financing parties in Table 3.

According to the Modigliani–Miller theorem, the value of ‘the firm’s average cost of capital ... is the ratio of its expected return to the market value of all its securities’ (Modigliani & Miller, 1958, 1963). Thus, the target capital structure in Example 1 is based on market values of debt and equity. Assuming a stable capital structure, it is possible to calculate the market value of debt and equity for every period. First, the market total project value (V) has to be calculated in each period. This demands discounting particular free cash flows to the end of subsequent periods. Hence the project value at time zero (V_{FCFF0}) is equal 4119.4. The value is calculated as discounted FCFF generated by the project from time 1 to the end of the estimation period. Taking into account a 40% share of debt in total value at each stage of the project, it is possible to calculate the implied market values of debt at time 0 ($4119.4 * 40\% = 1647.8$). For the end of year 1, the calculation of the market total project value is based on the remaining FCFF; thus, the free cash flow created in year one is not taken into consideration. Project market value and the market value of implied debt at the end of each period are presented in Table 4.

Free cash flow to equity (FFCE)

Application of Modigliani–Miller assumptions in the valuation process is a precondition for harmonising NPV calculations based on the FCFE or FCFF approach. The financial costs in FCFE are estimated by multiplying the cost of debt with the market value of debt at the beginning of every period.

Table 4. Project and debt market value at the end of each period (Example 1).

Period		0	1	2	3
Project value at the end of period	V_{FCFF}	4119.4	3032.8	1768.8	300.0
Share of debt in the capital structure	U_d	1647.8	1213.1	707.5	120.0
Debt value at the end of period	D	4119.4	3032.8	1768.8	300.0

Source: Authors' calculation.

It shall be noted that the residual value assumed in NPV calculation using the FCFE technique is not equal to the residual value given in calculation of NPV using the FCFF technique. Residual values in both techniques are different because they represent different economic categories. In the case of the FCFF approach, residual value reflects the FCFF from assets sale or liquidation and/or reinvestment to the benefit of all financing parties. The FCFE technique, in turn, presents only free cash flow gained by the owners. Thus, in the residual value for equity holder's calculation (RV_{FCFE}), the amount of the interest-bearing debt has to be subtracted from the residual value for all financing parties (RV_{FCFF}) at the end of the project. According to the calculations presented in Table 4, the value of debt in the last period of analysis equals 120. Thus, we arrive at the residual value for equity ($RV_{FCFE} = 180$).²

Both calculations of NPV come to an identical value for the project (2019.4), but the IRR results are different. However, this phenomenon is easily interpretable. The FCFF technique presents surplus allocated to both financing parties. The value of IRR calculated on such a basis represents the average rate of return on the overall invested capital. In reality, however, each source is characterised by a different expected rate of return. The cost of external capital calculated after considering the tax shield effect amounts only to 6.48% = (8%*(1-19%)). This fact has been included in FCFE calculation (Table 5) since in this case the financial costs of debt constitute a charge to the streams of free flows to owners. A lower cost of debt than the cost of equity created an additional surplus for the owners. On one hand, incurring of debt reduced the necessity of involving expensive equity capital; on the other, the cost of interest and capital repayments charged the free flows for owners in subsequent years. The effect of discounting negative financial outflow with high expected rate of return for shareholders reduces the impact of external financing on NPV. This may suggest that to increase the return on equity capital, investment projects should be financed with external capital to a maximum extent. Such a conclusion, however, can be premature and hazardous. Therefore, this issue is discussed in detail in the next section of the article.

Table 5. NPV and IRR calculation based on the FCFE technique for Example 1.

Period		0	1	2	3	
	Operating profit	EBIT	1000.0	1100.0	1200.0	
-	Financial costs	Int	131.8	97.1	56.6	
=	Profit before tax	PBT	868.2	1002.9	1143.4	
-	Tax	Tax	165.0	190.6	217.2	
=	Profit after tax	PAT	703.2	812.4	926.2	
+	Amortisation	A	700.0	700.0	700.0	
-	Working capital investment	WCI	20.0	30.0	30.0	
-	Capital expenditures	I	2100.0			
+	Debts incurred (+) / repaid (-)	D_n / D_R	1647.8	-434.6	-505.6	-587.5
+	Residual values for owners	RV_{FCFE}			180.0	
=	Free cash flow for owners	FCFE	-452.2	948.6	976.8	1188.6
	Discounted FCFE (D FCFE)		-452.2	846.9	778.7	846.0
	NPV		2019.4			
	IRR		207.7%			

Source: Authors' calculation.

Economic value added (EVA)

Using NPV calculation with the EVA approach demands an estimation of capital invested at the beginning of each planning period. This capital reflects the values of fixed assets and expenditure of working capital reduced by the costs of amortisation for a given period. The value of invested capital calculated in such a way constitutes the foundation for calculating EVA (according to equation (4)) in the particular period (as presented in Table 6).

The EVA in the last period of projection was increased by the residual value calculated according to the EVA concept (RV_{EVA}). This value constitutes the difference between the market value of the sold or liquidated assets ($RV_{FCFF} = 300$) and the value of the capital involved in project implementation at the end of the analysis period ($CI_4 = 80$).

It should be noted that the IRR method is not applicable when an investment project is evaluated with the EVA technique. Due to the fact that EVA presents a surplus return over the cost of involved capital, it omits the initial capital expenditure in the process of calculation.

An identical NPV value can be obtained by starting the analysis either with the EVA or FCFE technique. Again, it is necessary to maintain identical assumptions, including those concerning the value of implied debt used for calculating NPV based on the FCFE technique. It has to be assumed that there are precise patterns of incurring and repaying debts, stemming, for instance, from the credit repayment schedule. Under such conditions, WACC used in NPV calculation (based on FCFF or EVA techniques) reflects the capital structure of the project, and not of the company implementing the project. An example of harmonising different techniques of NPV calculation on similar assumptions was presented by Marciniak (2001). The application of such an approach in practice poses a threat of taking actions that are against the rules of value-based management.³

In the described case, market WACC in Table 7 is calculated on the basis of implied market debt and equity at the end of subsequent periods. The calculation of the present value of equity for the first period (based on FCFE calculation) is presented below:

$$V_{(FCFE_0)} = 9,486/(1 + 0.12) + 9,768/(1 + 0.12)^2 + 11,886/(1 + 0.12)^3 = 2471.7 \quad (6)$$

Example 1 proves the uniformity of NPV results when market values are used for calculating WACC (which is tantamount to values calculated on the basis of discounted

Table 6. Calculation of EVA for Example 1.

Period		0	1	2	3
Capital invested at the beginning of period	CI_{t-1}		2100.0	1420.0	750.0
- Amortisation	A		700.0	700.0	700.0
+ Capital expenditures	I	2100.0	0.0	0.0	0.0
+ Working capital investment	WCI		20.0	30.0	30.0
= Capital invested at the end of period	CI_t	2100.0	1420.0	750.0	80.0
Net operating profit after tax	NOPAT		810.0	891.0	972.0
Economic values added	EVA		604.4	752.0	898.6
RV_{EVA}					220.0
EVA + RV_{EVA}			604.4	752.0	1118.6
Discounted EVA + RV_{EVA}			550.5	623.8	845.2
NPV			2019.4		

Source: Authors' calculation.

Table 7. Calculating WACC based on market value of equity and debt.

Period		0	1	2	3
Gross value of equity at the end of period	V_{FCFE}	2471.7	1819.7	1061.3	180.0
Value of debt	D	1647.8	1213.1	70.5	120.0
Gross value of the project	V_{FCFF}	4119.4	3032.8	1768.8	300.0
Share of equity	U_d	0.6	0.6	0.6	0.6
Share of debt	U_e	0.4	0.4	0.4	0.4
Weighted average cost of capital	WACC		9.79%	9.79%	9.79%

Note: Capital structure items are based on market values.

Source: Authors' calculation.

future free cash flow), although different calculation techniques were used. Such an observation may lead to a conclusion that in the process of capital budgeting, any of the techniques can be used, for in the end each of them leads to an identical result. However, this way of reasoning is wrong. The next two sections present arguments pointing out the dangers related to the assumption of full interchangeability of each of the techniques.

3. Limitation and risk of FCFE application

Example 2 illustrates the risks arising from the FCFE technique in valuing investment projects.

Example 2. Company AAA examines an investment project with the following parameters

The financial analyst evaluating this investment will use the FCFE technique, assuming other approaches would result in the same results. The scale of the project within the company is relatively small; therefore, the potential increase in the project debt level should not cause an increase in the required rate of return by the owners. The investment can be debt financed with an interest rate of 8%, to be paid over 5 subsequent years. Expected rate of return for the owners is 15% and expected tax rate is 19%. Three financing options for the project are taken into account:

- Option I, without external capital.
- Option II, a loan financing 50% of initial capital investments.
- Option III, a loan financing 100% of initial capital investments.

Option I, no debt financing

With all equity (no debt) financing, the NPV based on the FCFE technique can be calculated directly from the data presented in Table 8 (values of FCFE are equal to the

Table 8. Assumptions for Example 2.

Period	0	1	2	3	4	5
Investments	-5000					
FCFF	-5000	1300	1300	1300	1300	1300

Source: Authors' calculation.

values of FCFE). Discounting of particular free cash flows using the expected rate of return ($r_e = 15\%$) leads to $NPV = -642$.

Option II, a loan financing 50% of capital investments

Calculating the NPV value based on the FCFE technique when 50% of investment is financed with debt requires a more complex calculation of FCFE. Results are shown in Table 9 (based on formula 3).

Calculation results clearly show the increase of NPV due to debt financing effects that enhanced the NPV value without changing its actual profitability. The increase of NPV is a consequence of cheaper debt financing compared with more expensive equity sources. At the same time, we used the assumption that the investors did not react to such a relatively small (in the scale of company operations) debt increase.

Option III, a loan financing 100% of initial capital investments

The NPV calculation based on the FCFE technique when 100% of investment is financed with debt is presented in Table 10 (based on formula 3).

Increased debt financing of an investment project and NPV calculation based on the FCFE technique pushed the project's value into the positive area just by the magic of financial leverage. This is a well-known consequence of engaging cheaper debt sources

Table 9. NPV based on FCFE for Example 2 (50% debt).

Period		0	1	2	3	4	5
Free flow for firm	FCFF	-5000	1300	1300	1300	1300	1300
+ Incurring loans	D_N	2500					
- Repaid loans	D_R		500	500	500	500	500
- Interest after tax	$Int^*(1-T)$		162	129.6	97.2	64.8	32.4
= Free flow for owners	FCFE	-2500	638	670	703	735	768
D FCFE		-2500	555	507	462	420	382
NPV		-174					

Source: Authors' calculation.

Table 10. NPV based on FCFE for Example 2 (100% debt).

Period		0	1	2	3	4	5
Free flow for firm	FCFF	-5000	1300	1300	1300	1300	1300
+ Incurring loans	D_N	5000					
- Repaid loans	D_R		1000	1000	1000	1000	1000
- Interest after tax	$Int^*(1-T)$		324	259.2	194.4	129.6	64.8
= Free flow for owners	FCFE	0	-24	41	106	170	235
D FCFE		0	-21	31	69	97	117
NPV		294					

Source: Authors' calculation.

with fixed costs despite shifts in a company's risk profile. According to the classical theory of finance, the cost of debt is lower than the cost of equity capital. By incurring debt, the initial equity participation in the project is reduced. This leads to smaller capital expenditures in calculation of NPV with the FCFE technique. The incurred debts get repaid in later periods and their cost is lower than the cost of equity capital. What is more, the distant repayments of the debt are discounted with the rate of return expected by the owners, so the rate is higher than the cost of debt. According to the rules of financial mathematics, an increase of the discount rate reduces the influence of the distant flows on the outcome of evaluation. As a result, the value of NPV grows and the higher the difference between the cost of equity and debt capital, the greater this effect gets. It was assumed that the increase of debt would not lead to an increase in the rate of return expected by owners. In other words, the beneficial value impact of debt financing is expected to be higher than the potentially adverse effect of a cost of equity increase. This is consistent with Proposition II in the Modigliani-Miller theory with taxes.

The existence of the described mechanism may suggest that to increase the value of a project, the debt financing should be increased. Such a solution is suggested by the FCFE technique. However, it should be clearly emphasised that actions directed at increasing the level of debt, although effective from the point of view of the project, may lead to negative consequences for the owners and lenders. According to the traditional theory of the cost of capital, there is a level of debt for a company, where the value of WACC is lowest and the value of a company is highest at the same time. Exceeding the optimal level of debt might look like a good idea for increasing the value of equity in the short-term, but the risk of financial distress will grow disproportionately. According to Example 2, the financial analyst applying the FCFE technique for calculating NPV would come to the conclusion that the subsequent project would be profitable provided that the cheaper debt capital is used. A focus on the increase of profitability in subsequent projects creates the risk of increasing the financial leverage of the whole company. In effect, the local increase in project profitability (NPV) by increasing the debt may lead to the growth of financial risk for the whole company and to the rise of the expected rates of return and, consequently, to the decrease of company value.

Such a mechanism worked, among others, in the case of some Polish property development companies in 2006 to 2010. The author's own consulting experience during this period found that a portion of these companies performed evaluations using the FCFE technique. In negotiations with banks, they stated that the higher the use of external capital in project financing, the bigger the net present value of the project. Since the implementation of particular investments did not involve separation of financial risk from the entity taking up a project (there were loan warranties of mother companies, for loans taken by a special purpose vehicle (SPV) implementing the investments), the cost of capital for property development companies increased with new projects being undertaken. Thus, a value degrading mechanism was established, which gathered ever more financial leverage and risk, but from the perspective of a single project manager or analyst, it looked like a stroke of genius.

Some authors point out⁴ that the financing of subsequent investments with debt corresponds with the concept of value-based management, provided that a given company did not reach the optimal level of debt. An additional argument speaking in favour of such an approach is the much bigger availability of debt capital for investment projects than, for example, the process of share repurchase, which would allow in effect optimisation of the sources of financing. Such a line of reasoning would theoretically be able

to justify the application of the FCFE technique in evaluation of investment projects at least to the point where the given company reaches the optimal structure of financing.

Such an approach, however, carries some hazards as well. Application of the FCFE technique in such cases may lead to the effects of project displacement. It is hard to take bank loans for research and development or organisational changes, but some projects, like hard infrastructure construction and projects granting good bank warranties, can be financed with external capital well above the average level. Therefore, it should be also emphasised that even standard projects evaluated by the FCFE technique conceal some application risks.

The technique better adapted to the needs of value management is FCFF. This tool allows for separation of investment decisions from activities in the scope of maintaining an optimal capital structure. Moreover, if the technique is applied correctly, it does not lead to negative selection of projects for which no debt financing can be obtained. Of course, the question about the 'correct application' of the FCFF technique is crucial at this stage and will be discussed in the next section.

4. Limitation and risk of project WACC application in NPV calculation

The identified weaknesses inherent in the FFCE and EVA approaches indirectly indicate FCFF as the most promising capital budgeting technique. FCFF seems to present a more holistic and comprehensive picture of business activities and cash flow consequences. Despite identical outcomes of the analysed approaches, the FCFF technique, contrary to FCFE, allows avoiding the uncontrolled debt increase. Nevertheless, it should be pointed out that a very common error related to inappropriate WACC estimation is used with FCFF and EVA-based investment project evaluation (Mielcarz & Paszczyk, 2013). The problem is presented in Example 3.

Example 3

A certain company is considering an investment project demanding 1 million in capital expenditures, which is to generate a FCFF at the level of 100,000 forever. The company is financed 30% by external capital with an interest rate of 7%, and 70% by equity expecting the rate of return of 15%. The tax rate is 19%. Estimate the NPV of the project with the following options:

- (1) We use company WACC.
- (2) We use project WACC under the assumption of 100% debt financing provided by bond issuance. We assume that bonds will be rolled over until the end of the project.

Option 1, using company WACC

Calculation of WACC for the whole company:

$$\text{WACC} = 0.7 \times 15\% + 0.3 \times 7\% \times (1 - 0.19) = 12.2\% \quad (7)$$

The NPV value of investment can be calculated with Gordon's equation assuming zero growth in FCFF.

$$\text{NPV} = -1,000 + \frac{100}{0.122} = -180.3 \quad (8)$$

NPV value of the project amounts to -180.3 . Thus, the project appears irrational, since it cannot reach the rate of return expected by the capital lenders.

Option II, using project WACC

WACC calculation:

$$\text{WACC} = 0 \times 15\% + 1 \times 7\% \times (1 - 0.19) = 5.67\% \quad (9)$$

Again we use Gordon's equation assuming zero growth in FCFF:

$$\text{NPV} = -1,000 + \frac{100}{0.0567} = 736.7 \quad (10)$$

NPV calculations based on the project WACC falsely indicates that the project is profitable. This is the result of using a lower discount rate in the case of performing WACC calculation based on the capital structure of the project. Such a result may suggest that using project WACC in the analysis makes the investment more appealing. The argument against such a line of reasoning is exactly the same as the one presented in the discussion on the issue of maladjustment of the FCFE technique to evaluation of investment projects (see the previous section). The application of WACC calculated on the basis of the project financing structure in capital budgeting encourages debt financing of a company even further. This can result in a situation where every subsequent loan would lead to an increase in the company's WACC, followed by a decrease in the company's value and most probably leading into financial distress. Using the project WACC at the stage when the company has not achieved the optimal capital structure creates the risk of displacement of projects that cannot be financed with external capital (as was described earlier). Thus, applying the rules of value based management, the analytical solutions making use of a project's capital structure in the process of a project's investment evaluation shall be rejected.

5. Summary

Our recommendation can be summed up by a well-known proverb: 'Le bon Dieu est dans le détail'. We demonstrated that simultaneous analyses with three different calculation techniques would be superfluous, as we must obtain the same NPV value. However, this is not true for IRR. Its calculation based on free cash flows for all financing parties represents the average rate of return on the whole capital, whereas the IRR calculation based on FCFE reflects the rate of return for the owners only. To provide a full picture of profitability for different interest groups, one should calculate NPV based on FCFF and IRR based on both FCFF and FCFE techniques. The application of the EVA technique does not allow for calculating the IRR; thus, it does not provide additional information compared with FCFF and FCFE. Moreover, the EVA algorithms are not commonly known and are probably less acknowledged and recognisable among decision makers and analysts compared with the FCFF technique. These factors impose limits on the possibilities of application of the EVA technique in the process of capital budgeting.

Using the FCFF technique causes fewer threats of jeopardising the owner's interests. The FCFE approach can cause a higher risk of over-investing or under-financing the company (using too high a debt/equity ratio). The application of the FCFF approach may lead to similar problems when using project WACC instead of the marginal cost of capital of the whole company. Therefore, FCFF discounted with company WACC

should be pointed out as the appropriate solution from the value-based management perspective.

Project finance undertakings are an exception to the rule. Our observation based on a few cases is in line with and John (1996) and Mlinarič (2012) who tried to substantiate that project finance transparency results in a diminished information asymmetry. To achieve such results, the financial risk of a project company has to be separated from the financial risk of the superior entity. In such a case, the above-average increase of debt of the special purpose vehicle (SPV) does not raise the cost of capital of the superior entity. Therefore, there is no risk of decreasing the value of the whole capital group due to the increase of financial distress risk. At the same time, the superior entity (and/or its owners) has to be diversified and immune to losses that may occur as a result of bankruptcy of the SPV. In other words, the level of diversification of different investments in the superior entity should allow for amortisation of potential losses resulting from, among others, a high level of debt in the SPV.

Notes

1. For clarity reasons, we decided to simplify the EVA calculation and omit the issue of corrections to EBIT and CI calculations proposed by Stern Stewart & Co. A majority of the corrections affect the EBIT calculation and CI symmetrically. Thus, they should not have a significant impact on the final conclusions concerning the discussed issue as far as the same corrections would be applied in the process of FCF calculation.
2. This reconciliation technique of NPV calculation based on FCFF and FCFE is also appropriate for the situation where residual values are calculated based of the perpetuity formula. In this case: $RV_{FCFF} = \frac{FCFF(1+g_{FCFF})}{WACC-g_{FCFF}}$ (a) $RV_{FCFE} = \frac{FCFE(1+g_{FCFE})}{r_e-g_{FCFE}}$ (b) knowing that: $RV_{FCFE} = RV_{FCFF} - D$ (c) and: $g_{FCFF} \neq g_{FCFE}$. It is possible to calculate the value of perpetuity growth rate for the FCFE technique (g_{FCFE}) that will reconcile both the residual values and NPV calculations. $g_{FCFE} = \frac{(RV_{FCFF}-D)r_e-FCFE}{(RV_{FCFF}-D)+FCFE}$ (d).
3. See Section 3.
4. Compare leading authors of POT and TOT in the introductory section.

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