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Net Present Value Analysis and the Wealth Creation Process: A Case Illustration

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Abstract

This teaching case is intended to help students on accounting undergraduate and postgraduate courses deepen their understanding of capital budgeting. Knowledge of an investment project's net present value (NPV) is important but not sufficient. Shareholders would also like to know how and when a project pays the NPV it generates. We show in monetary amounts, how much each investor group receives in every time period as well as the timings of those payments.

Introduction

The Net Present Value (NPV) method as an investment appraisal or capital budgeting technique shows how an investment project affects company shareholders' wealth in present value terms. Maximizing shareholders' wealth is an important goal for management, and investment projects with positive NPV are wealth enhancing and should be accepted. To calculate a project's NPV, we discount its future free cash flows[1] using a discount rate, add the discounted free cash flows and subtract the initial investment from the total. If the end result is positive the project should be accepted; if it is negative, then the project should be rejected. Very often, the process looks mechanical (akin to a black box) once the project's free cash flows are known and, more importantly, it does not distinguish between the various claimants of a project's free cash flows, who are the suppliers of capital to the project and the company shareholders.

In this teaching case we make the assumption that those who supply the financing for a project, which we refer to as the *capital suppliers*, and the *company shareholders* are different, i.e., the latter do not invest in the project. Then the

[1] Free Cash Flow = Cash Flow from Business Operations *minus* Investment in Fixed Assets *minus* Investment in Net Working Capital. In other words, Free Cash Flow represents the cash that can be paid to investors (i.e., those who financed the project) and shareholders without affecting the project. It is also commonly referred to as *Net Cash Flow*.

distribution of a project free cash flows consists of three elements: (i) the payment of the cost of capital[2] to the *capital suppliers*, (ii) the repayment of the principal (or initial investment or capital supplied) to the *capital suppliers* again, and (iii) the excess wealth generated for the *company shareholders*. The cost of capital is the rate of return demanded by those who supplied capital for the investment, i.e., the *capital suppliers*. The principal represents the initial amount invested in the project by the same people. The excess wealth represents the cash available after repayment of the cost of capital and the principal amount in full, which is paid to the *company shareholders*. In this article, we show how the three elements of the free cash flows are determined and when they are paid. We show precisely when an investment project starts to create wealth for the *company shareholders*, whom we treat as a separate group from those who supplied capital for the project.[3]

The teaching case can be used in a final year undergraduate- and/or postgraduate accounting course. It can be delivered during a group learning activity in a seminar session or assigned for independent study. The case should enhance students' understanding of how project free cash flows are distributed amongst the capital supplies and shareholders, respectively. It should also make clear the importance of the discounted payback period in breakeven analysis.

Following this opening section, we first review the relevant literature and then introduce a working/ hypothetical example that is used for our case illustration. This is followed by a calculation of the NPV derived from the hypothetical case. We then go on to demonstrate how free cash flows are distributed among three groups of stakeholders: (i) how the cost of capital is paid to *capital suppliers*; (ii) the amount of principal[4] repaid to *capital suppliers*; and (iii) the excess wealth generated for *company shareholders*. Last but not least, we demonstrate that there is only one relevant payback period that takes into account both repayment of principal and cost of capital to *capital suppliers*.

Literature Review

The topic of capital budgeting has attracted the interest of many scholars (see, for instance, De La Mare, 1975; Levy and Sarnat, 1978; Pike, 1996; Arnold and Hatzopoulos, 2000). The main methods of capital budgeting include payback, internal rate of return, accounting rate of return and net present value (NPV). Wnuk-Pel (2014) finds that the NPV method is the most popular. A U.S.-based survey by Payne et al. (1999) documents that 75% of the sample companies use the NPV method. Arnold and Hatzopoulos (2000) estimate NPV usage in the UK at 80% of their sample companies. Bennouna and Merchant (2010) estimate that 94% of Canadian companies use NPV.

However, the popularity of a method varies by firm size. The aforementioned surveys apply to large firms. Conversely, Moor and Reichert (1983), and Trahan and Gitman (1995) find that small firms favor the use of the payback method. Small businesses tend to rely heavily on debt financing and their business models are subject to higher levels of uncertainties compared to larger firms, which confound the application of the NPV method.

The type of the cash flows that are used in capital budgeting exercises has also been studied. For instance, Pogue (2004) shows how the use of continuous cash flows rather than periodic cash flows directly impacts the decision to accept or reject an investment. Pogue (2004) also reviews the techniques to assess project's continuous cash flows (also see Buck and Hill, 1971; De La Mare, 1975; Levy and Sarnat, 1978; Ismail, 1994).

Bierman and Smidt (1993), and Drury and Tayles (1997) explain how one should isolate the effects of non-cash expenses from project cash flows—for instance, depreciation and amortization expenses. They also review the

[2] The cost of capital is the rate of return demanded by those who are supplying capital for an investment project. We will assume that it is determined solely by the project's risk, i.e., it is independent of who is financing the project.
[3] The discount rate and the cost of capital mean the same thing for the purpose of this paper. All future cash flows are discounted at the cost of capital.
[4] It is not important that the two groups, i.e., *capital suppliers* and *company shareholders*, are treated separately. Nonetheless, this distinction makes it clearer how existing company shareholders benefit/lose from a proposed investment.

treatment of finance costs and inflation. Project cash flows should not include the cost of financing since the latter is already included in the discount rate. Cash flows should be expressed in nominal form as well as the cost of capital. Else, real cash flows (i.e., after removing the effects of inflation) and a real discount rate should be used.

Two other key inputs in investment appraisal are the discount rate and the riskiness of the project cash flows (Lee, 1988; Jenkins, 1994; Cho, 1996; Akalu, 2001). The discount rate should reflect the project's risk. The starting point tends to be the firm's own weighted average cost of capital (i.e., WACC), which includes its cost of debt and equity financing (also see Berry et al., 2014), respectively. Given the tax benefit of debt financing, the WACC includes the after-tax cost of debt. There are several methods to calculate the cost of equity and the most common ones include the capital asset pricing model (CAPM) (Sharpe, 1964; Lintner, 1965) and the dividend growth model (DGM) (Gordon, 1959).
To the extent that a project's risk profile differs from that of its sponsoring company, then the discount rate should be adjusted to reflect the project's risk as opposed to the company's risk. Ross et al. (2005) advocate adopting either a subjective- or a pure play approach to estimate the discount rate. Under the subjective approach, projects are ranked according to their perceived risks with higher discount rates assigned to the riskier ones. Under the pure play approach, consideration is paid to the discount rates used by other companies that operate in the same industry and exhibit the same risk attributes as the proposed investment. Furthermore, the discount rate is adjusted to reflect the capital structure profile of the project rather than the sponsoring company.

We add to the literature of capital budgeting and investment appraisal by showing explicitly how an investment project's cash flows are distributed in the form of income to capital suppliers, repayment to capital suppliers and the distribution of the excess cash flows to the company shareholders.

Working Example - Hypothetical Case Illustration

A publicly traded company is evaluating an investment project that requires an initial investment of $1,000,000. The project will last for four years and will generate $400,000 in free cash flows annually. The project is of equal risk as the company's existing operations and its cost of capital is 10 per cent per annum.[5] Those who provide the $1,000,000 could be either stockholders or bondholders; we refer to them simply as *capital suppliers*.[6] We assume that the all the cash flows occur at the end of the year. Table 1 shows the project's initial investment and free cash flows. Year 0 is now; Years 1 to 4 represents the four years of the project's life, in that order. The initial investment is $1,000,000. The project lasts for four years and generates $400,000 in free cash flows annually.

Table 1: Project's Cash Flows

	Year 0	Year 1	Year 2	Year 3	Year 4
Initial Investment	-1,000,000				
Project's Free Cash Flows		400,000	400,000	400,000	400,000

Calculation of Net Present Value
The project's NPV is calculated as follows:

$$NPV = CF_0 + \frac{CF_1}{(1+R)^1} + \frac{CF_2}{(1+R)^2} + \frac{CF_3}{(1+R)^3} + \frac{CF_4}{(1+R)^4}$$

where, NPV represents net present value, CF represent cash flows and R represents the discount rate. The subscripts 0, 1, 2, 3, 4 and 5 represent their respective years.

[5] *Principal* and the *initial amount invested* in the project are used interchangeably.
[6] We ignore the effect of taxes. While incorporation of taxation effects would be more realistic, it would also complicate the presentation without changing the central theme of the paper, i.e., the distribution of a project's free cash flows.

$$NPV = -1,000,000 + \frac{400,000}{1.10^1} + \frac{400,000}{1.10^2} + \frac{400,000}{1.10^3} + \frac{400,000}{1.10^4} = 267,946$$

We discount the annual free cash flows of $400,000 by the cost of capital. The present value of the total discounted free cash flows is $1,267,946 and exceeds the initial investment of $1,000,000. Therefore, the project's NPV is $267,946 and represents the extra wealth that it creates for the *company*'s *shareholders*. Under the NPV rule, the project is accepted.

The solution can also be obtained as follows:

Present value of free cash flows annually:	
($400,000 per year for 4 years at 10%: $400,000 × 3.169865)	$1,267,946
Deduct net initial investment	$1,000,000
Net Present Value	$267,946

Distribution of Project Free Cash Flows

Table 2 shows the distribution of the free cash flows over the project's life.

Table 2: Distribution of Free Cash Flows

Year	1	2	3	4
Project Free Cash Flows (FCFs)	400,000	400,000	400,000	400,000
Cost of Capital paid to *Capital Suppliers*	100,000	70,000	37,000	700
FCFs *minus* Cost of Capital	300,000	330,000	363,000	399,300
Principal Amount Repaid to *Capital Suppliers*	300,000	330,000	363,000	7,000
Excess Wealth paid to existing *Company Shareholders*	0	0	0	392,300

The initial capital supplied (which we will also refer to as the *principal amount*) for the project is $1,000,000 at a cost of capital of 10 per cent per annum. By the end of Year 1, the project needs to repay a year's cost of capital to the *capital suppliers*, i.e., 10 per cent of $1,000,000 ($100,000). First, the cost of capital is paid out of the $400,000 free cash flows in Year 1; then, the $300,000 left is used to repay part of the initial $1,000,000 invested by the *capital suppliers*, leaving only $700,000 of their money in the project.

By the end of Year 2, the project generates another $400,000 in free cash flows. Cost of capital paid to the *capital suppliers* equals to 10 per cent of $700,000, i.e., $70,000. Once the cost of capital is paid, an excess of $330,000 in free cash flows are available to repay another portion of the initial $1,000,000 invested by the *capital suppliers*. Therefore, at the start of the following year, i.e., Year 3, *capital suppliers* have only $370,000 (i.e., $700,000 *minus* $330,000) invested in the project.

Cost of capital paid to the *capital suppliers* at the end of Year 3 equals to 10 per cent of $370,000, i.e., $37,000. After that payment is made, the remaining $363,000 will pay back another portion of the principal owed to the *capital suppliers*. Therefore, by the end of Year 3, the total amount of principal repaid to the *capital suppliers* equals to $993,000 (i.e., $300,000, $330,000 and $363,000 at the end of Years 1, 2 and 3, respectively), leaving only $7,000 of the original $1,000,000 contributed by the *capital suppliers* as unpaid.

The amount of the cost of capital paid to the *capital suppliers* at the end of Year 4 equals to 10 per cent of $7,000, i.e., $700. They are still owed $7,000 in principal balance. Subtracting the money owed to the *capital suppliers* in Year 4 from the free cash flows leaves an excess of $392,300. That excess belongs to the project owners, i.e., the *company shareholders*. Notice that the latter's share of the free cash flows starts in Year 4, which coincides with the discounted payback period as we will show in the next section. The excess cash of $392,300 is four years away. Its present value (discounted at the project's discount rate of 10 per cent over four years) equals to $267,946, which is the same as the project's NPV.

$$Present\ Value\ (Excess\ Cash\ Flow\ of\ Year\ 4) = \frac{Excess\ Cash\ Flow\ of\ Year\ 4}{(1+R)^4}$$

$$\text{Present Value of the Year 4 Excess Wealth} = \frac{392,300}{1.10^4} = 267,946$$

Therefore, the NPV equals to the present value of the Year 4 excess free cash flows that belong to the *company shareholders*.[7] We summarize the two beneficiaries of the project's free cash flows in Table 3.

Table 3: Summary of Payment of Project's Free Cash Flows

	Year 0	Year 1	Year 2	Year 3	Year 4
Free Cash Flows paid to *Capital Suppliers*	-1,000,000	400,000	400,000	400,000	7,700
Free Cash Flows paid to *Company Shareholders*	0	0	0	0	392,300
Project's Total Free Cash Flows	-1,000,000	400,000	400,000	400,000	400,000

The Effective Payback Period

If all the free cash flows were used to repay the principal only (i.e., no payment of cost of capital, which is implausible), then the $400,000 of year 1 and the $400,000 of year 2 free cash flows will cover 80% of the initial $1,000,000 investment. We need half of the third year $400,000 free cash flows to recover the full $1,000,000 invested in the project. Therefore, the project's payback period, a concept that is only relevant to the *capital suppliers*, would be 2½ years (we will refer to that period as the project's *simple payback*). However, our analysis in the preceding section shows that the principal is not fully repaid in 2½ years because the entire free cash flows is not available for the repayment of principal only; the cost of capital must be paid out of the same free cash flows.

Table 2 shows that the cumulative amount of principal repaid to the *capital suppliers* is only $993,000 by the end of Year 3. Thus, it takes more than 3 years to payback the *capital suppliers* their $1,000,000 (as we show in the equation below). Recall that $700 (i.e., 10% of $7,000) of the Year 4 free cash flows is used to pay the cost of capital on the $7,000 in principal that was due at the start of that year. Consequently, only $399,300 (i.e., $400,000 - $700) is available toward principal repayment. If we assume that the cash flows accrue evenly throughout the year, we need 0.02 (i.e., $7000 divided by $399,300) of Year 4 to repay the $7,000 in principal due at the start of the year.[8] Accordingly, the real payback period is 3.02 years (i.e., the *discounted payback period*).

$$\text{The effective payback period} = 3\ \text{years} + \frac{7,000}{400,000 - (10\%\ \text{of}\ 7,000)} = 3.02\ \text{years}$$

A survey by Graham and Harvey (2001) reveals that 56.7 percent of CFOs use the simple payback method as an investment appraisal technique, and only 30 per cent use the discounted payback method.[9] CFOs should be aware that the simple payback period is not achievable (as we showed above). Nonetheless, we envisage a few reasons to support its popularity. First, the simple payback method is easier to grasp for managers who are not experts in capital budgeting. It is an easier way to communicate the importance of a project to nonfinancial managers without them feeling overwhelmed by numbers. Facilitating communication among departments is important as such exchanges can lead to improvements and increases in the value of a project. Next, the simple payback method is an effective tool to eliminate poor projects before more time is spent on the valuable ones. For example, if the simple payback period is inferior to the target set by investors, then the project should be discarded as the decision would be the same under the

[7] Expenses associated with raising capital are excluded from the analysis. We assume that the initial investment in the project is net of any issue cost.

[8] By excess we mean the part that is left after repayments to the *capital suppliers*.

[9] If we do not make that assumption and that all cash flows occur at the end of a year, then the payback period is the full four years.

discounted payback method. Therefore, the simple payback method's attractiveness lies in its simplicity. Nonetheless, to assess the value of a project based solely on that method is ill-advised.

While the simple payback method calculates an imaginary payback period, it still leads to the correct decision for all projects that are also accepted under the discounted payback method. A discrepancy between the two methods occurs when the payback period criterion lies between the two. In such instances, the simple payback period will wrongly lead to acceptance of the project. This is a problem for venture capitalists, who provide startup financing, and investors in distressed companies and would like to know the exact payback period. While they do not always invest for the short-run, their business model depends, to a large extent, on how long a venture takes to succeed or how long it takes to turn around the fortune of a distressed company. The issue is also important for a manager whose job depends on short-term results. Lastly, unlike the simple payback method, the discounted payback method will always reject projects that do not generate positive NPVs; an important feature that is highly desirable and, which can also thwart short-term behaviors.

What if the Free Cash Flows in a given year does not cover the Cost of Capital?

Consider an equivalent project but with slightly different cash flows in years 1 and 2 as shown in Table 4. The cost of capital is still 10% per year.

Table 4: Alternate Project's Cash Flows

	Year 0	Year 1	Year 2	Year 3	Year 4
Initial Investment	-1,000,000				
Project's Free Cash Flows		50,000	785,000	400,000	400,000

The project NPV is calculated as follows:

$$NPV = -1,000,000 + \frac{50,000}{1.10^1} + \frac{785,000}{1.10^2} + \frac{400,000}{1.10^3} + \frac{400,000}{1.10^4} = 267,946$$

The NPV is still $267,946, similar to our previous example. However, the dollar amount of the cost of capital in Year 1 is 10 per cent of $1,000,000, i.e., $100,000. The project's free cash flows in Year 1 amount to $50,000 and fall short of the $100,000 cost of capital that needs to be paid to the *capital suppliers*. Does it mean that the *capital suppliers* are not earning 10% on their investment in Year 1 as the project does not have sufficient cash flows in that year to pay the full amount of the cost of capital? The answer is no, and we explain why, using the figures reported in Table 5.

Table 5: Distribution of Alternate Project Free Cash Flows

Year	0	1	2	3	4
Amount borrowed from *Capital Suppliers*	-1,000,000				
Project Free Cash Flows (FCFs)		50,000	785,000	400,000	400,000
Cost of Capital paid to *Capital Suppliers*		50,000	155,000	37,000	700
FCFs *minus* Cost of Capital		0	630,000	363,000	399,300
Principal Amount Repaid to *Capital Suppliers*		0	630,000	363,000	7,000
Excess wealth paid to *Company Shareholders*		0	0	0	392,300

The cost of capital paid in Year 1 should have been $100,000 instead of $50,000 as shown in Table 5. However, since the project generates only $50,000 in free cash flows, the project is able to pay only half of the Year 1 cost of capital. No principal amount is repaid in that year. As a result, the project owes $50,000 to the *capital suppliers* in unpaid return (i.e., part of the cost of capital) in Year 1. We treat any unpaid amount as a loan (or further financing) from the *capital suppliers* to the project at its cost of capital. Free cash flows permitting, the *capital suppliers* expect to recover that amount with *interest* (i.e., their demanded rate of return of 10%) at the end of the following year, i.e., $50,000 * (1 + 10%) = $55,000.

In Year 2, the cost of capital that needs to be paid to the *capital suppliers* equals to 10% of the principal (i.e., 10% of $1,000,000 = $100,000) *plus* the $55,000 as calculated in the preceding paragraph. Therefore, in Year 2, out of the $785,000 the project generates in free cash flows, the total amount of cost of capital paid to the *capital suppliers* equals to $155,000; leaving $630,000 toward the repayment of their principal.

The year 3 cost of capital paid to the *capital suppliers* equals to 10% of $370,000 ($1,000,000 *minus* principal of $630,000 repaid in Year 2), i.e., $37,000. After the $37,000 is paid, the remainder amount (i.e., $363,000) is used to repay another portion of their principal. In Year 4, the principal amount due to the *capital suppliers* is only $7,000; therefore, the Year 4 cost of capital is $700 (i.e., 10% of $7,000). $7,000 is used to repay the remainder of the principal balance, leaving an excess wealth of $392,300 for the *company shareholders*. Discounting the $392,300 by 10 per cent over four years yields a net present value of $267,946. As a result, if in a given year, a project's free cash flows fall short of its cost of capital, the project is still viable for the *company shareholders* as long as the total free cash flows over the project's life exceeds the total repayment of principal and cost of capital to the *capital suppliers*.

Alternative Distributions of Free Cash Flows

Let us assume that the project in Table 1 was financed by lenders solely (we will refer to them as *bondholders* or *debtholders*). Given that the project is the same, they demand the same required rate of return, i.e. 10 per cent per annum. The only difference is that the principal amount will now be amortized in equal installments over the project's life, i.e., $250,000 annually. We show the distribution of the free cash flows in Table 6.

Table 6: An Alternative Distribution of the Project's Free Cash Flows

Year	0	1	2	3	4
Amount borrowed from *Capital Suppliers*	-1,000,000				
Project Free Cash Flows (FCFs)		400,000	400,000	400,000	400,000
Cost of Capital paid to *Capital Suppliers*		100,000	75,000	50,000	25,000
FCFs *minus* Cost of Capital		300,000	325,000	350,000	375,000
Principal Amount Repaid to *Capital Suppliers*		250,000	250,000	250,000	250,000
Excess wealth paid to *Company Shareholders*		50,000	75,000	100,000	125,000

The debtholders initially provide $1,000,000 to invest in the project. The project generates $400,000 in free cash flows yearly over the next four years. Interest paid on the loan at the end of Year 1 is 10 per cent of the loan amount and equals to $100,000; principal repaid in the same year is $250,000. Out of the $400,000 free cash flows, $50,000 in excess cash is left (i.e., $400,000 *minus* $100,000 *minus* $250,000), which is paid to the *company shareholders*.[10]

The balance of the principal amount owed to the debtholders at the start of Year 2 is $750,000. Therefore, the amount of interest that needs to be paid at the end of Year 2 is 10% of $750,000, i.e., $75,000. A second payment of $250,000 is also made to the debtholders to repay part of the principal balance owed to them. The excess cash remaining in Year 2 for the *company shareholders* is $75,000 (i.e., $400,000 *minus* $75,000 *minus* $250,000).

At the start of Year 3, the principal amount of the loan that is still due is $500,000. Therefore, interest of $50,000 is paid at the end of Year 3 along with $250,000 in principal repayment to the debtholders. The excess cash flow that belongs to the *company shareholders* at the end of Year 3 is $100,000 (i.e., $400,000 *minus* $50,000 *minus* $250,000). Likewise, at the end of Year 4, $25,000 in interest (i.e., 10% of $250,000) and a final principal repayment of $250,000 are paid to the debtholders. The excess wealth remaining for the *company shareholders* is $125,000 (i.e., $400,000 *minus* $25,000 *minus* $250,000) in Year 4. The year-end cash flows to the *company shareholders* are as follows:

[10] The survey is cited in number of accounting research articles investigating the use of different investment appraisal techniques (see for instance Brunzell, Liljeblom, & Vaihekoski, 2013 and Frezatti et al., 2013).

\$50,000 in Year 1, \$75,000 in Year 2, \$100,000 in Year 3 and \$125,000 in Year 4. The NPV of the project to the *company shareholders* (or the present value of their share of the project's free cash flows) is calculated as follows:

$$NPV = \frac{50,000}{1.10^1} + \frac{75,000}{1.10^2} + \frac{100,000}{1.10^3} + \frac{125,000}{1.10^4} = 267,946$$

The project's NPV is still \$267,946, the same as first calculated. Therefore, a project's NPV is invariant to the way in which its free cash flows are distributed and is consistent with Modigliani and Miller (1958) Proposition One, i.e., that the market value of a firm is independent of its capital structure. In our example, that would translate to: the NPV of a project is independent of its financing.

The Accrual Accounting Rate of Return Method

Besides the aforementioned methods, firms can also use the accrual accounting rate of return (AARR) method to evaluate investments. The advantage of the AARR method is that it resembles a profitability ratio, a concept that is familiar to most investors. In formula terms, the AARR is obtained as follows (Horngren, Datar and Rajan (2015)):

$$AARR = \frac{Increase\ in\ expected\ average\ annual\ after\ tax\ operating\ income}{Net\ Initial\ Investment}$$

Consider a project that is expected to increase a firm's expected average annual after tax operating income by £0.63 million. Its net initial investment is £7 million. Its AARR is 9% as calculated below.

$$AARR = \frac{£0.63\ million}{£7\ million} \times 100 = 9\%$$

Conclusion

This teaching case shows how a project's free cash flows are distributed, i.e., how much is in the form of (i) the cost of capital paid to those who financed the project, (ii) the repayment of the initial investment to the same group of people, and (iii) the excess wealth generated for the project's owners, i.e., the *company shareholders*. Such a distribution is not necessarily obvious in the way NPV exercises are usually presented in class. It is important for shareholders to know how and when they can cash in the excess wealth generated by a project, which is the essence of this case. Our analysis of the distribution of a project's free cash flows also shows that its NPV and its discounted payback period are related in the sense that the first one shows how much shareholders' wealth is created and the second one shows when that wealth starts to accrue. The article also establishes that there is only one achievable payback period, i.e., the discounted payback period. Lastly, the article shows that the net worth a project is independent of how its free cash flows are paid out to its *capital suppliers* and its shareholders.

The teaching implications are highlighted in the case study found in the Appendix, where we attempt to apply the analysis of the distribution of project's free cash flows. We also revisit the interpretation of NPV to company shareholders in the latter part of the case study, a topic that can be used as the basis for further class discussion on NPV.

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Teaching Case: Jet-Make Inc Decision to Build and Market a Brand New Aircraft

Jet-Make Inc., an aircraft manufacturer has been toying with the idea of building a brand new long-range 250-seater aircraft for the past year. While the fuselage, wings and tails of existing aircrafts are mostly made of heavy materials (like aluminum, steel and titanium), the new aircraft will be 50% made of lighter composite (i.e., plastic-like) materials. It will be 20% more fuel efficient than existing similar sized aircrafts, thus allowing airline companies to save considerably on jet fuel costs.

In 2X09, Jet-Make Inc. started exploratory study to ascertain the viability of the proposed new aircraft, which included customer surveys with airline companies and aircraft leasing companies, and meetings with various stakeholders including engineers, employees, suppliers, airport management and government authorities. The whole process, undertaken on a global scale, ended in 2X11. Market interest in the proposed new aircraft was very high, especially from Middle-Eastern and Asian carriers. The total cost of the exploratory study is $50 million.

After analyzing all the inputs, Jet-Make Inc. decided to go ahead and build the new aircraft. Computer design and performance simulation of a virtual prototype will start in 2X12, i.e., the project's starting year. Heavy-engineering work on the aircraft will start in 2X13. Testing and certification will be completed by 2X15 and the first delivery will take place in 2X16. A total of $15 billion will be invested to develop the aircraft distributed as follows: $10 billion in research and development expenses; $2 billion to buyout strategic suppliers; $3 billion toward building five test models that will not be sold and will be written off.

The company is also setting aside $1 billion for working capital needs, which it expects to fully recover in the final year of the project. A consortium of venture capitalists and investment banks (not the shareholders of the company) will 100% finance the project. The money required for the initial investment will be available at the end of 2X11. The consortium also agreed to provide the requisite financing to cover $180 million in administrative expenses in 2X12.

Jet-Make Inc. will present a virtual prototype to potential customers at the Paris Air Show 2X13, Dubai Air Show 2X13, the Asian Aerospace Air Show 2X13 in Hong Kong and the Farnborough Air Show 2X14. The air shows are held every other year. Jet-Make Inc. expects to market the aircraft at the air shows until 2X21 beyond which it will need a major redesign to be marketable. The company does not expect any order for the current planned version of the aircraft starting 2X22; nonetheless, deliveries will continue past that date until all the orders are fulfilled. Marketing expenditure will stop in 2X21 as a result. Expenditure on marketing will be higher in the first few years after the aircraft is built and can be customized and flown to potential customers. Marketing costs (in $ millions) will be as follows:

Year	2X13	2X14	2X15	2X16	2X17	2X18	2X19	2X20	2X21
Marketing Costs	$70M	$70M	$140M	$210M	$210M	$140M	$70M	$70M	$70M

Participation at the air shows will cost $1 million each. Starting 2X15, Jet Make Inc. will fly a model of the aircraft to the air shows both for exhibition and to perform demonstration flights. Flying and exhibiting an aircraft will cost an additional $1.5 million per air show.

The company is expecting to book orders for 100 units of the aircraft at every air show. Customers will make a down payment of 5% of the final price at the time they place an order, a second payment of 10% the following year and the remainder upon delivery. The list price of the aircraft is $150 million. Airline companies typically negotiate huge discounts on aircraft orders. On average, Jet-Make Inc. is expecting a 22 per cent discount off the list price. Deliveries of the new aircrafts are scheduled as follows: 6 units in 2X16; 30 units in 2X17; 90 units in 2X18; 138 units in 2X19; and, 240 units yearly starting 2X20.

The average cost of the first few planes are expected to vastly exceed their selling price. Jet-Make Inc. forecasts that the first six units (excluding the five test models) will cost $300 million apiece as they will need a lot of rework, modifications and other "unk-unks" [1]. A second batch of 18 aircrafts will cost $150 million each for similar reasons. The average cost per unit will drop to $100 million starting with the 25th aircraft.

Starting with the 25th unit, it is expected that over time Jet-Make Inc. will become more efficient at making the aircraft. The production cost will fall by 3 per cent after every 240 manufactured units, i.e., if the first 240 units (unit 25 to unit 264) cost $100 million/unit to manufacture, then the second 240 units (i.e., unit 265 to unit 504) will cost $97 million/unit, the third 240 units (i.e., unit 505 to unit 744) will cost $94.09 million/unit, and so forth.

Expenses associated with Warranty and After-Sales Repairs are usually high in the initial years of the project. Jet-Make Inc. estimates the annual costs associated with Warranty and After-Sales Repairs to be $90 million in 2X17, $100 million in 2X18, $90 million in 2X19, $120 million in 2X20, $60 million in 2X21, $30 million in 2X22, $30 million in 2X23, and $15 million per year thereafter. At the end of the project, further work to be performed on Warranty and After-Sales Repairs will be outsourced to a third party at a one-time fee of $150 million.

Other costs associated with the project include $180 million in general administrative expenses yearly starting 2X12 until the project's final year. Furthermore, customer orders for aircrafts will be manufactured and delivered in the same year.

Commensurate with its high risk, Jet-Make Inc. will apply a discount rate of 12 per cent to the project. For calculation purposes, assume that the cash flows occur at the end of the year.

Questions:

1. Calculate the project's simple Payback Period, Net Present Value, Internal Rate of Return and Discounted Payback Period?
2. Evaluate the distribution of the project's Free Cash Flows to the following groups: (i) *capital suppliers*, and (ii) *company shareholders*?
3. Explain when you expect the project to start to create wealth for Jet-Make Inc.'s shareholders?
4. Discuss to what extent the project's calculated NPV at the given discount rate may understate the true increase in shareholders' wealth?

Note

[1] Aerospace jargon for "unknown unknowns".

Teaching Explanations (For Educators Only)

In Table A.1, we show the various figures that we need to perform a discounted cash flow (DCF) analysis. The initial investments amount to $16 billion and the $1 billion investment in net working capital (NWC) will be recovered at the end of year 2X26, i.e., the final year of the project. Customer aircrafts' manufacturing and delivery start in 2X16 and end in 2X26. The direct production cost per unit starts high at $300 million per unit and declines over the years as Jet-Make Inc. becomes more efficient at making the aircraft. The learning curve represents one *minus* the 3% decrease in cost per unit per batch (a batch is 240 units) starting with the 25^{th} aircraft. The realized selling price per unit after discount is $117 million.

Jet-Make Inc. will participate in all the aforesaid air shows from 2X13 to 2X21. The number of units ordered at each air show is 100. Over the project's life, the total number of units ordered is 1,900. As a result, only 196 aircrafts will be delivered in the final year. Participation at each air show costs $1 million and the cost of flying and exhibiting the aircraft costs an additional $1.5 million per air show.

Table A.1. Data Inputs for the Discounted Cash Flow Analysis

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Year		2X11	2X12	2X13	2X14	2X15	2X16	2X17	2X18	2X19	2X20	2X21	2X22	2X23	2X24	2X25	2X26
	$M	$M	$M	$M	$M	$M	$M	$M	$M	$M	$M	$M	$M	$M	$M	$M	$M
Initial Investment		15000															
Investment in NWC		1000															
Recovery of NWC																	1000
Units delivered							6	30	90	138	240	240	240	240	240	240	196
Cumulative units delivered							6	36	126	264	504	744	984	1224	1464	1704	1900
Direct Production Cost per unit							300	130	100	100	97	94	91	89	86	83	81
Learning Curve	97%																
Selling price per unit	150																
Discount	22%																
Selling price after discount	117																
Number of air shows				3	1	3	1	3	1	3	1	3					
Units ordered/air show				100	100	100	100	100	100	100	100	100					
Orders	1900			300	100	300	100	300	100	300	100	300					

Aside from the direct production costs, the other recurring expenses include General Administration, Marketing, Warranty and After-Sales Repairs. At the end of 2X26, further work needed on Warranty and After-Sales Repairs will be outsourced to a third-party at a one-time fee of $150 million.

Customers will pay 5% of the discounted price at the time they place their order, 10% the following year and the remainder upon taking delivery of the aircrafts. The DCF analysis is presented in Table A.2. Notice that there is a single cash outflow in 2X12 and no inflows. Investors provide the cash in that year to meet the outflow. The NPV of the project is $1,439.93 million. Since the NPV is positive, the project will add to the *company shareholders*' wealth. The project's Internal Rate of Return (IRR) is 13.31% and is in excess of the project's discount rate of 12%. The IRR is the discount rate, which when applied to the free (or net) cash flows leads to a zero NPV. Thus, using the IRR criterion, the project is valuable to the company.

The distribution of the free cash flows is exhibited in Table A.3. The shareholders of Jet-Make Inc. do not receive any cash until 2X25 and 2X26, i.e., years 14 and 15 in the project. They receive $3,188.21 million in 2X25 and $4,310.74 million in 2X26. The present value of these payments in 2X11 is the same as the project's NPV:

$$\text{Present Value of years 14 and 15 Excess Wealth} = \frac{3{,}188.21M}{1.12^{14}} + \frac{4{,}310.74M}{1.12^{15}} = \$1{,}439.93\text{M}$$

The project's discounted payback is 13.13 years, which coincides with the time shareholders start receiving some payoffs from the project.

Notice that 100% of the project financing is provided by a consortium of venture capitalists and investment banks, i.e., the *capital suppliers*, and the *company shareholders* contribute none. Yet the project pays cash to the *company shareholders* in 2X25 and 2X26. It is evident that the *company shareholders* are not assuming as much risk in this project as are the *capital suppliers*. Therefore, discounting the free cash flows that belong to the *company shareholders* at the project's discount rate of 12% may be too high, thus understating the NPV of the project to them. Furthermore, irrespective of the discount rate, the project will add to shareholders' wealth as long as it returns a $1 in excess of what it owes to the *capital suppliers*. We might as well conclude that any investment project with a discounted payback period that falls within its lifetime is beneficial to the *company shareholders*.

Table A.2. Project's Discounted Cash Flow Analysis, Payback Period, Net Present Value, Internal Rate of Return and Discounted Payback Period

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Year		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
	$M	$M	$M	$M	$M	$M	$M	$M	$M	$M	$M	$M	$M	$M	$M	$M	$M
Initial Investment		15000															
Investment in NWC		1000															
Direct Production Costs							1800	3900	9000	13800	23280	22582	21904	21247	20610	19991	15836
General Admin Costs	180		180	180	180	180	180	180	180	180	180	180	180	180	180	180	180
Marketing Costs				70	70	140	210	210	140	70	70	70					
Warranty & After-Sales Repairs Costs								90	100	90	120	60	30	30	15	15	15
Outsourcing Warranty & After-Sales Repairs																	150
Participation Cost @ air shows	1			3.00	1.00	3.00	1.00	3.00	1.00	3.00	1.00	3.00					
Flights' Cost @ air shows	1.5			4.50	1.50	4.50	1.50	4.50	1.50	4.50	1.50	4.50					
TOTAL OUTFLOWS		16000	180	258	253	328	2193	4388	9423	14148	23653	22899	22114	21457	20805	20186	16181
1st down payment	5%			1755	585	1755	585	1755	585	1755	585	1755					
2nd down payment	10%				3510	1170	3510	1170	3510	1170	3510	1170	3510				
Payment upon delivery	85%						597	2984	8951	13724	23868	23868	23868	23868	23868	23868	19492
Recovery of NWC																	1000
TOTAL INFLOWS		0	0	1755	4095	2925	4692	5909	13046	16649	27963	26793	27378	23868	23868	23868	20492
Free (or Net) Cash Flows		-16000	-180	1498	3843	2598	2499	1521	3623	2502	4311	3894	5264	2411	3063	3682	4311
Cumulative Net Cash Flows		-16000	-16180	-14683	-10840	-8243	-5743	-4222	-599	1902	6213	10107	15371	17782	20845	24527	28837
Discount Rate	12.00%																
Net Present Value (NPV)	1,439.93																
Internal Rate of Return (IRR)	13.31%																
Simple Payback	7.24																
Discounted Cash Flow		-16000	-161	1194	2735	1651	1418	771	1639	1010	1554	1254	1513	619	702	753	788
Cumulative Discounted Cash Flows		-16000	-16161	-14967	-12232	-10581	-9163	-8392	-6754	-5743	-4189	-2935	-1422	-803	-101	652	1440
Discounted Payback Period	13.13																

Table A.3. Distribution of Project's Free Cash Flows

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Year		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
	$M	$M	$M	$M	$M	$M	$M	$M	$M	$M	$M	$M	$M	$M	$M	$M	$M
Initial Investment		16000															
Project's Free Cash Flows (FCFs)			-180	1498	3843	2598	2499	1521	3623	2502	4311	3894	5264	2411	3063	3682	4311
Cost of capital paid to Capital Suppliers			0	1498	3843	2598	2468	1521	2405	1792	1706	1394	1094	594	375	53	0
FCFs minus Cost of Capital			-180	0	0	0	32	0	1218	710	2604	2500	4170	1817	2688	3629	4311
Principal repaid to Capital Suppliers			-180	0	0	0	32	0	1218	710	2604	2500	4170	1817	2688	441	0
Excess Wealth for the Company Shareholders			0	0	0	0	0	0	0	0	0	0	0	0	0	3188	4311
Principal due @ start			16000	16180	16180	16180	16180	16148	16148	14930	14220	11616	9116	4946	3129	441	0
Cost of Capital due to Capital Suppliers			1920	4092	4847	3067	2468	1938	2405	1792	1706	1394	1094	594	375	53	0
Principal due @ end		16000	16180	16180	16180	16180	16148	16148	14930	14220	11616	9116	4946	3129	441	0	0
Interest unpaid			1920	2595	1005	470	0	417	0	0	0	0	0	0	0	0	0
NPV	1,439.93																