

On the Rate of Return and Valuation of Non-Conventional Projects

Carlos Heitor Campani

Professor of Finance at COPPEAD Graduate School of Business
(Federal University of Rio de Janeiro) Research Associate of EDHEC-Risk Institute,
E-mail: carlos.heitor@coppead.ufrj.br

ABSTRACT

I provide a solution for evaluating non-conventional projects, firstly showing that the well-known modified internal rate of return does not answer correctly what investors want to measure. Even if one correctly uses the net present value criterion for capital budgeting, I show that it fails for non-conventional projects. My contribution is thus twofold: To yield the correct rate of return for non-conventional projects and to allow practitioners to correctly calculate comparable net present values to take correct investment decisions.

Keywords: Project valuation, Rate of return, Non-conventional cash flows, Modified internal rate of return, NPV and IRR.

JEL classification: G11, G31

1. INTRODUCTION

Although there is a consensus that capital budgeting decisions should be made in light of the net present value criterion (*aka*, NPV), the internal rate of return (*aka*, IRR) is still broadly used by practitioners (see for example Jaffe, Ross and Westerfield (2012)). The NPV technique, if correctly used, provides the value created by the project, having taken into account its risk: All the rest equal, any efficient capital budgeting policy must focus on the creation of value. The IRR criterion, as it is very well known, presents several problems that may lead to (very) wrong investment decisions: The timing and scale problems when comparing different projects as well as myopic perspective and possibility of multiple IRRs with non-conventional cash flows¹. While timing and scale problems can be easily bypassed if one uses the NPV criterion (another argument for the NPV criterion!), the problems arising from non-conventional cash flows *cannot* !

On top of these problems, the *modified* internal rate of return (*aka*, MIRR) was created under the hope that would solve them². However, Keef and Olowo-Okere (1998) correctly highlight that the MIRR inherits all the IRR problems except one: The multiple rates problem. This article corroborates this view and proposes a straightforward solution to the valuation and consequently the comparison of projects with non-conventional cash flows.

It is important to understand that the rate of return of a project should be the answer to the following question: “If I, as an investor, put my money on this project, what is the rate of return that I can expect while the project pays me back?”. Notice that this definition is the same as if the project were interpreted as a loan. If I stick to this simple and intuitive definition, the standard internal rate of return will work perfectly to conventional cash flows³. Nevertheless, with non-conventional cash flows, this will no longer be true for the IRR, let alone for the MIRR. First of all, the MIRR does not translate itself into a fair rate of return for the investor. I will show that its definition leads to a mixed interest rate and does not reflect what the investor needs to know. Perhaps more importantly, the MIRR does not solve at all the problems arising from using the NPV criterion to investment decisions: In other words, even if the MIRR were a reliable rate of return for projects, it would not help in correctly deciding which project should be undertaken in the presence of multiple options.

¹ A conventional cash flow scheme is one in which there is one or more initial outlays and once the first inflow takes place, the investor will not have any further outlay. In other words, there is a single change of sign in the cash flow scheme. Under a non-conventional cash flow scheme, more than one sign change take place.

² It is true that some different methodologies for the MIRR were proposed, but I prefer to discuss in this article the classical one available in softwares such as MS-Excel. None of the others has become a success among practitioners and their formulations either presented flaws or a non-straightforward reasoning that departed from the meaning that most of (if not all) practitioners give to the rate of return of a project, as defined in here. For a discussion and references on this matter, see Hartman and Schafrick (2004).

³ Notice that this does not mean that the IRR criterion will work perfectly when comparing projects, and indeed, will not, since the objective is always to create more value as opposed to get the highest rates.

In a survey with 392 CFOs, Graham and Harvey (2001) find that the IRR method is the number one technique used to evaluate projects, being used by nothing less than 75.6% of the interviewees (NPV comes just after, 74.9%). This finding lets us conclude that practitioners still want to know the rate of return for the projects they invest in and this is the greatest motivation to write this paper: To provide practitioners a reliable rate of return for non-conventional projects (reliable here means the true answer to the question raised earlier). However, I stress out that even with a true measure of the project rate of return, one cannot rely on the rate criterion. Efficiently, the methodology presented in this paper to calculate the rate of return of a (non-conventional) project will also lead to a reliable NPV approach.

To focus on what really matters and convey my ideas more straightforwardly, I start in the following section with simple cases in which the issues are presented and discussed in a very clear way. I then illustrate the method with a lengthier non-conventional project in section 3, while section 4 will conclude this paper.

2. PROBLEM SPECIFICATION AND SOLUTION

Suppose a simple 3-period investment with the following cash flows:

$$\text{Year 0} \rightarrow CF_0 = -\$100.00$$

$$\text{Year 1} \rightarrow CF_1 = +\$250.00$$

$$\text{Year 2} \rightarrow CF_2 = -\$100.00$$

For example, the project above can be a simplification for a big event such as a Formula 1 GP, a rock and roll show or even a football world cup: in such events, the entrepreneur usually invests in a first moment to then receive the revenues due to sponsors, ticket sales etc to finally have to pay all those involved in the event as well as to shut the event off. Suppose that, given the risk of such project, a minimum discount rate of 40% per year is appropriate. First of all, if one just makes use of the NPV approach, it will accept this project because its NPV at 40% is positive: \$27.55. The IRR for this project is 100%, so someone using the IRR criterion would also accept it, since the IRR is greater than the required rate of return. It seems we have no problems here because both criteria converge, but indeed we do have a problem due to the non-conventional cash flows. Let us check what the MIRR would propose in such a case: The idea behind this procedure is to use two exogenous interest rates. The first one is the financing rate through which the company (owner of the project) is able to obtain funds: For example, for a very well established firm AAA graded, this financing rate should be very close to the economy riskless rate. In general, this rate is the yield obtained by the firm if bonds are currently issued (say, to finance the project). On its turn, the second interest rate needed in the MIRR approach is the so-called investment rate through which the company is readily able to invest its funds. With the financing rate, all negative cash flows are brought back to time 0 while all positive cash flows are taken forward to the last period of the project through the investment rate. The MIRR is then defined as it follows:

$$MIRR = \sqrt[n]{\frac{FV(\text{PositiveCashFlows}, \text{InvestmentRate})}{PV(-\text{NegativeCashFlows}, \text{FinancingRate})}}$$

Notice that in doing this, the MIRR naturally transforms the project into a (convenient) conventional project. The question here is: Does it make sense? Doing such, is the rate thus obtained the rate of return that the investor can expect to achieve while the project pays him back? The answer is no.

The idea behind the MIRR is that future cash outlays can be financed with the financing rate while intermediary cash inflows will be reinvested at the investment rate. A natural question here is what should be the investment rate: The standard approach is to use the weighted average cost of capital of the firm. Nonetheless, the MIRR approach mixes concepts! Firstly, there is no point to the firm to bring to period 0 all cash outlays, and in fact doing this damages the value of good projects⁴. Secondly, when it assumes the money is reinvested at an exogenous rate (whatever it is), we are just mixing a zero-NPV project to the project under consideration. The zero-NPV is a supposed secondary project in which cash inflows will be reinvested until the last period of the original project, and this cannot be a positive NPV project otherwise the value created by other project would be

⁴ In other words, the NPV thus obtained is lower than its correct value.

double-counted in here⁵. Although adding a zero-NPV project to our original project does not change its value, this indeed changes its rate of return such that in the end we are obtaining in fact an average rate that is not necessarily equal to (and in general will not be) the rate of return of the original project.

Switching back to the project proposed above, I consider that the company (possibly) undertaking the investment is a triple-A rated company that can virtually borrow at the riskless rate, set at, say, 10% per year. I assume that the project has exactly the same risk as the company, such that its cost of capital (investment rate) is also 40%. In this case, one can easily calculate the MIRR⁶ as equal to 38.4%, providing a negative NPV of -\$4.07. So the MIRR approach would suggest not to invest on this project.

My approach to correctly calculate the expected rate of return of the project and its expected NPV (thus being able to take correct decisions) is explained now. To simplify matters and maintain the focus, I assume that the negative cash flows are known and therefore can be discounted at the riskless rate of return (if this is not the case, one can easily adapt my method accordingly)⁷. The idea is to convert the project into a conventional one anticipating negative cash flows up and only to the previous period with a positive inflow. If the positive inflow is not sufficient to maintain itself non-negative after this anticipation, the process continues till we get a conventional project. For instance, the adjusted cash flows for our project here becomes:

$$\text{Year 0} \rightarrow CF_0 = -\$100.00$$

$$\text{Year 1} \rightarrow CF_1 = +\$159.09$$

$$\text{Year 2} \rightarrow CF_2 = \$0.00$$

Providing a correct NPV of \$13.64 with an IRR of 59.1%. Observe that the negative cash flow of period 2 was anticipated to period 1: $\$159.09 = \$250 - \$100/1.10$. This means that the project should indeed be undertaken, so the MIRR analysis would lead to the incorrect decision. But, does the adjusted cash flows above reflect the original project? Yes, they really do reflect. One could easily explain this point noticing that if the investor knows in period 1 that he will have a cash outlay in the next period, he can save $\$90.91 = \$250 - \$159.09$, invest at the riskless rate and match it exactly with the outlay of period 2. The investor could only perceive the adjusted cash flows and use the standard NPV and IRR as realistic performance measures of the project.

Let me give here another example, taken from Jaffe, Ross and Westerfield (2012):

$$\text{Year 0} \rightarrow CF_0 = -\$100.00$$

$$\text{Year 1} \rightarrow CF_1 = +\$230.00$$

$$\text{Year 2} \rightarrow CF_2 = -\$132.00$$

The problem here is even more serious because there are two IRRs, 10% and 20%. Although the problem of multiple IRRs is very well known by the literature, still its solution is not! Even top-rated textbooks get misled here and for instance Jaffe, Ross and Westerfield (2012) say on page 147:

“Of course, we should not be too worried about multiple rates of return. After all, we can always fall back on the NPV rule.”

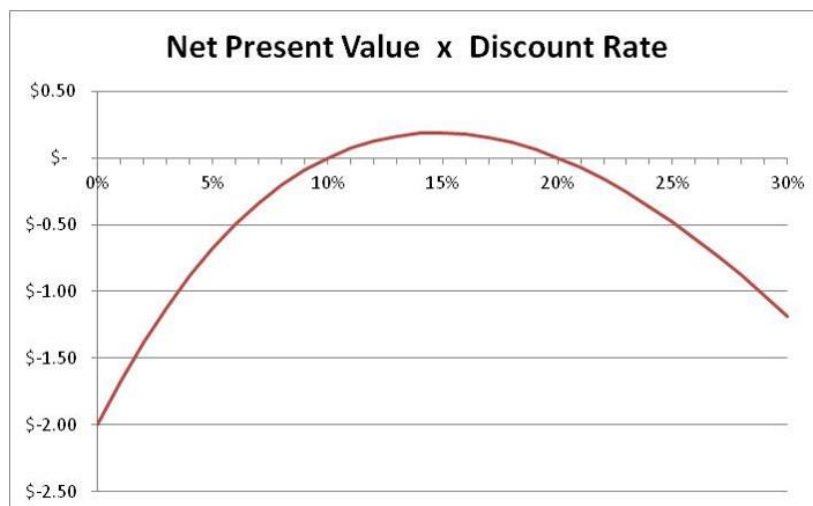
⁵ By the way, that is exactly why the standard approach is to reinvest at the firm's weighted average cost of capital. And in fact, the secondary project can eventually have a non-zero NPV but this cannot be taken into account in the original project.

⁶ There is an additional puzzle here relative to the MIRR approach: Given that the last positive cash-flow is at period 1, should we consider this as the last period of the project or alternatively should we consider period 2 even if there is no positive cash flow on it? The answer does impact both the MIRR and the NPV. In practice, the most common approach is to consider the original length of the project.

⁷ Anyway, we can always assume that such project exists (*i.e.*, with known and certain negative cash flows) to at least show that the MIRR and the NPV will provide misleading numbers and that the method presented in this paper works.

This is wrong. Figure 1 plots the standard NPV as a function of the hurdle rate for the project. Using the NPV rule would mean to accept the project for discount rates between 10% and 20%. But what if a hurdle rate of just 5% was the correct one? For the investor, a lower hurdle rate represents a more valuable project but according to the NPV criterion, in this case the project would be discarded. Why does the NPV criterion fail here? Just because the non-conventional cash flows makes the one investing in the project being *invested* from period 1 to period 2. Therefore a higher rate of return in such case means higher interests *paid*, which is definitely not what an investor wants. To see this, let me pick the IRR of 10%: Initially the project owner invests \$100, such that in period 1 he would have \$110, according to the IRR. However, he receives back more than that and thus he himself owes the balance of \$120. Now he is paying the 10% rate, explaining the negative cash flow of \$132 in the last period.

Figure 1: I plot below the NPV of the project discussed above as a function of the discount rate. We see that this project presents two IRRs.



The behavior commented on the previous paragraph (created by the non-conventional cash flows) makes the NPV to completely lose its meaning and as a consequence also the criterion based on it. To make a correct analysis one needs to use the method presented by this paper. To do so, I keep the same rates and assumptions of the previous example, except that now this project is considered a lot less risky and hence the hurdle rate is lower, at 15%. Although the NPV misleading criterion would justify the investment, my method reveals a bad project: the IRR is equal to 10.0%, generating an NPV of -\$4.35. Notice that our investor knows for sure that he will have a negative outlay in period 2 so he must at period 1 set aside the necessary amount to match it. Doing so, he ends up with a simple project in which he invests \$100 and receives in one period \$110, such that his expected return is 10%. But given that this project is risky and would deserve an expected return of 15%, he prefers to invest in the riskless rate which will give him the same 10%, but with no risk involved.

Before proceeding to a more complex example, it is important to consider another simple one, as follows:

$$\text{Year 0} \rightarrow CF_0 = -\$100.00$$

$$\text{Year 1} \rightarrow CF_1 = -\$120.00$$

$$\text{Year 2} \rightarrow CF_2 = \$288.00$$

Assume that the firm understands that the appropriate hurdle rate for this project is 18%. I want to highlight that as this is *not* a non-conventional project (only one sign change), so there is no need to adjust the cash flows. Adjusting the cash flows in such case would be equivalent to applying the MIRR methodology (since I am assuming a triple-A firm in which the financing rate is the riskless rate):

$$\text{Year 0} \rightarrow CF_0 = -\$209.09$$

$$\text{Year 1} \rightarrow CF_1 = \$0.00$$

$$\text{Year 2} \rightarrow CF_2 = +\$288.00$$

The MIRR is 17.4% and its NPV is -\$2.25, so we would reject this project. However, the IRR and NPV of the original project (which is a nested case of my method) are respectively 20.0% and \$5.14: The project should be accepted! Why this is the correct IRR (and consequently the correct NPV)? Just think the project as a loan with a 20% interest rate: At time 0 you lend \$100 to the project such that at time 1, the project owes you \$120. Then you lend \$120 further, such that your balance now is \$240. At period 2, your updated balance is $240 \times 1.20 = \$288$, which is exactly what the project gives (or is expected to give) you back.

3. ILLUSTRATION OF THE METHOD

I provide now a lengthier project to make my method even clearer. Consider an investment with the following expected cash flows:

| Period | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|----------------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Cash Flow (\$) | -100 | -100 | -100 | +200 | +200 | +200 | -100 | +200 | +200 | +100 | -200 | -200 | +250 |

I maintain a riskless rate of 10% but now the project risk is such that a 30% required rate of return is appropriate. As before, I assume that the negative cash flows are surely known at time 0 so that we can discount them at the riskless rate. I stress that this is just a simplification of matters to make the analysis developed by this study more transparent, but not really necessary. Were the negative cash flows risky, one would have to use any model to determine the appropriate discount rate for the outlays and then apply the method explained here in the usual way.

Should the firm undertake this project? The standard IRR of this project is 31.4% so a myopic investor would accept this project. The standard NPV is, at 30%, equal to \$9.00 corroborating the myopic view⁸. But by now the reader should understand that these measures are no longer reliable for a non-conventional project. We need to adjust the cash flows setting aside part of the revenues to match the future investments needs:

| Period | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|----------------|------|------|------|------|------|---------|---|---------|---|---|----|----|------|
| Cash Flow (\$) | -100 | -100 | -100 | +200 | +200 | +109.09 | 0 | +177.60 | 0 | 0 | 0 | 0 | +250 |

Notice that the first three (negative) cash flows do not change, as explained in the previous section. On period 5, the investor sets aside \$90.91 ($200 - 109.09$) that, capitalized by the riskless rate, will exactly match the negative cash flow of period 6. This reasoning is repeated for periods 8 and 9 to match the outlays of periods 10 and 11 (here we need two periods of positive inflows). The adjusted (conventional) cash flows allow us to correctly calculate the rate of return provided by the project as equal to 29.0%. Why is this rate the one correct? Again, let you the reader be the investor. Me, your consultant, I tell you that this project is expected to provide you this rate of return. The table below sets your balance (total amount invested, taking into account the periodic return of 29.0%). Notice that when you get cash back, your balance (that is, the amount that the project is expected to owe you) decreases such that at the end of the 12 periods, your balance will be exactly equal to zero:

| Period | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|----------------|------|---------|---------|---------|---------|---------|--------|--------|--------|---------|---------|--------|----|
| Cash Flow (\$) | +100 | +228.99 | +395.39 | +310.03 | +199.92 | +148.80 | 191.94 | +70.00 | +90.29 | +116.47 | +150.24 | 193.81 | +0 |

As below the hurdle rate, the correct IRR already indicates this is not a good project. To confirm this, I calculate the correct NPV of the project as equal to the NPV of the adjusted cash flows (at 30%): -\$6.62. You, as requiring 30% per period, will not be willing to invest in such project! It is easy to notice how confusing (and misleading) can be the original NPV criterion with non-conventional projects, let alone both original IRR and MIRR rates.

4. CONCLUSION

I clarified in this paper that the modified internal rate of return is not an adequate solution for the problems associated to the analysis of non-conventional projects when using the internal rate of return or even the standard net present value techniques. More clearly, the modified IRR does not answer the question investors have in mind when they ask “what is the rate of return of this project?”. To correctly provide an answer to this question, I formulate in this article a simple and straightforward method not only to calculate the proper rate of

⁸ If we assume the same firm as before, with a reinvestment rate of 40%, the MIRR would be 30.4%, thus also suggesting a good project, since this rate is still greater than the hurdle rate.

return of a non-conventional project but also to provide a reliable NPV measure that can be compared and used to decide upon different projects. The NPV is comparable also because the (correct) valuation of conventional projects is nested in my model.

Although my method calculates the correct rate of return of any project, I observe that this does not mean that the IRR criterion could be used as ultimate investment criterion. As the capital budgeting analysis aims at adding value, the NPV criterion will still be the criterion to be used. However, now the NPV can be correctly calculated even for non-conventional projects.

REFERENCES

- Graham, J. R., & Harvey, C. R. (2001). The theory and practice of corporate finance: Evidence from the field. *Journal of Financial Economics*, 60(2/3), 187-243. doi: 10.1016/S0304-405X(01)00044-7
- Hartman, J. C., & Schafrick, I. C. (2004). The relevant internal rate of return. *The Engineering Economist*, 49(2), 139-158. doi: 10.1080/00137910490453419
- Jaffe, J. F., Ross, S. A., & Westerfield, R. W. (2012). *Corporate finance* (10th ed.). New York: McGraw-Hill.
- Keef, S., & Olowo-Okere, E. (1998). Modified internal rate of return: A pitfall to avoid at any cost! *Management Accounting*, 76(1), 50-51.