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Adding Depth to the Discussion of Capital Budgeting Techniques

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Adding Depth to the Discussion of Capital Budgeting Techniques

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The subject of capital budgeting generally encompasses a significant percentage of any beginning finance course with net present value (NPV) often receiving the most attention. Even after this substantial time allotment, critical assumptions and comparisons of the different techniques (such as payback period, discounted payback period, NPV and IRR) are frequently glossed over due to time constraints. Consequently, the goal of this paper is to present these non-NPV techniques in a manner that allows the beginning finance student to expeditiously see the intuition, inherent assumptions, and any connection with the more popular NPV calculation. A small portion of this paper may be more applicable to slightly more advanced finance students and can be introduced at the instructor's discretion. Further, the lesson plan takes advantage of Excel to provide a visual presentation of how a given technique is executed (the Excel templates are also appropriate for assignments).

INTRODUCTION

Project evaluation is one of the most pragmatic and essential topics to be covered in an introductory finance course. In its simplest form, a viable project simply needs to generate revenues that exceed its cost. It is in this context that the concept of payback period emerges. However, using a more realistic viewpoint, a viable project's revenues must also generate a return that is at least commensurate with the risk associated with its cash flows. It is this form of analysis that the concepts of discounted payback period, net present value (NPV), and internal rate of return (IRR) emerge.

Although the different project valuation methods are not necessarily mathematically sophisticated, the intricacies of the techniques tend to be difficult for students to fully grasp. NPV tends to be the dominant method of evaluation taught, and hence, students work harder to understand it better relative to the other metrics. We will focus primarily on the other methods with the goal of this paper being to provide an additional resource for teaching payback period, discounted payback period, and IRR. Excel is used to illustrate the concepts instead of being used in a "black box" fashion to generate an answer. Further, the Excel templates developed provide ample material for homework assignments or projects.

The first section introduces the payback period metric (PB). The second section discusses the discounted payback period metric (DPB) and the problems associated with PB and DPB. The third section discusses how net present value (NPV) resolves the problems associated with DPB and PB and also demonstrates how NPV, the internal rate of return (IRR), DPB, and PB are related. The fourth section focuses on the reinvestment assumption of NPV and IRR and introduces the concept of modified internal rate of return (MIRR). This section may be better suited for a slightly more advanced finance student and can be used at the instructor's discretion. The fifth section concludes the paper.

THE PAYBACK PERIOD METHOD

Of the project evaluation metrics available, the payback period is the simplest to calculate. The payback period is the number of time periods (generally in terms of years) it takes for the project's revenues to exactly recover the cost. Although one may be inclined not to teach such a simple method, a recent survey by Ryan and Ryan (2002) reports that firms still utilize the payback period method to a significant degree; 52.6% of the sample of 205 responding firms use the metric at least 75% of the time. The metric is more popular with smaller firms (capital budget under $100 million), more popular than the discounted payback method (discussed in the next section), and generally used in conjunction with another evaluation metric. Aside from pragmatic reasons, the benefit of teaching the payback period is that it aids in building the intuition for more sophisticated methods.

Suppose a project has an initial cost of $500.00 and it is expected to have annual revenues of $100.00, $200.00, $200.00, and $400.00 over the next four years. It will take three years for the revenues to accumulate to $500.00, at which point, the cost of the project has been recovered. Consequently, the payback period is "three years". To illustrate this in Excel, set up the cash flows along a time line and then, year by year, reduce the cost of the project until it reaches zero (see Figure 1).

Although the spreadsheet is not very difficult to implement, it can be elevated in its sophistication. Change the Year 3 cash flow to $100.00 in order to make the payback period greater than three years and less than four years. To produce the payback period, one must interpolate between Year 3 and Year 4. Only $100.00 of the $400.00 in Year 4 is necessary for recovering the project cost, which is 25% ($100.00 ÷ $400.00) of the year's revenue. Consequently, the new payback period is "3.25 years". The spreadsheet is adjusted in two steps: first, one needs to determine what can happen in a given year (the cost is not fully recovered, the cost is recovered, or the cost has already been recovered) and second, sum up the number of periods necessary for cost recovery. The first step requires a "nested IF statement" (i.e., an "= IF" statement within an "= IF" statement) in Excel and the second step is a summation. Figure 2 demonstrates the two step process.

Figure 1. The Payback Period in Excel

	A	B	C	D	E
1	Year 0	Year 1	Year 2	Year 3	Year 4
2	-$500.00	$100.00	$200.00	$200.00	$400.00
3	Cost Recovery:	-$400.00*	-$200.00**	$0.00***	$400.00***
4					
5					

*Cell Formula: = A2 + B2 **Cell Formula: = B3 + C2 ***Copy formula from cell C3

Figure 2. The Payback Period in Excel with Interpolation

	A	B	C	D	E
1	Year 0	Year 1	Year 2	Year 3	Year 4
2	-$500.00	$100.00	$200.00	$100.00	$400.00
3	Cost Recovery :	-$400.00[a]	-$200.00[b]	-$100.00	$300.00
4	Test Condition (Step 1):	1[c]	1[d]	1	0.25
5	Payback Period (Step 2):	3.25[e]			

[a]Cell Formula: = A2 + B2
[b]Cell Formula: = B3 + C2; Copy C3 to D3..E3
[c]Cell Formula: = IF(B3 <= 0, 1, IF(A2 > 0, 0,-A2/B2))
[d]Cell Formula: = IF(C3 <= 0, 1, IF(B3 > 0, 0, -B3/C2)); Copy C4 to D4..E4
[e]Cell Formula: = SUM(B4:E4)

Notice, the Excel spreadsheets illustrate how the payback period is calculated and also introduce some slightly sophisticated Excel programming to perform an interpolation if necessary. Consequently, the spreadsheets can be used simply to teach how the payback period is calculated in an illustrative manner and/or an assignment can be created to force the student to understand interpolation with the associated programming. If the student is assigned to create the spreadsheet, the spreadsheet can be tested by allowing the student to assess different sets of cash flows that change the payback period. Further, to reinforce the student's learning, provide a set of cash flows in which the cost is not recovered and have the student interpret what this means aside from the spreadsheet returning (in this case) a value of "4".

THE DISCOUNTED PAYBACK PERIOD METHOD (or Adjusted Payback Period)

The discounted payback period is the number of periods it takes to recover the cost of the initial investment using discounted cash flows. Consequently, unlike (undiscounted) payback period, this method recognizes that the revenue cash flows should not only recover the cost, but should also provide a return. To demonstrate the difference between payback period (PB) and the discounted payback period (DPB), change the cash flow (CF) series in Figure 2 into constant cash flows of $125.00 for years one to four. The student should notice that although the cost is fully recovered, this is not a viable project because the revenues do not generate any return. The next question becomes: how large of a return should the project generate based on its risk? It is this intuition that leads to the discounted payback period as a metric for project viability. The (undiscounted) payback period is:

$$PB = \frac{Cost}{CF} = \frac{\$500.00}{\$125.00} = 4\ years \quad (1)$$

but this fails to account for any return required due to the risk of the project. To gain intuition, augment the Excel programming in Figure 2 to include discounting and add a condition to allow the user to know if the cost is actually recovered as shown in Figure 3.

The addition of an "= IF( )" statement in cell B7 allows the user to know if the cost has not been recovered. A similar command can be introduced into Figure 2; =IF(E3 < 0, "COST NOT RECOVERED", SUM(B4:E4)) for cell B5, and can be assigned to the student as an exercise for augmenting Figure 2. Notice, the DPB must be greater than the undiscounted payback period due to the required return on the investment. It is no longer sufficient to "break even" on the initial investment. The discounted payback period for the cash flows from Figure 2 is 3.617 years which is greater than the undiscounted payback period of 3.25 years. To test if the algorithm is working correctly, change all of the revenue cash flows to $125.00 (again) and the spreadsheet should indicate that the cost is not recovered.

Although the current lesson plan adds to the intuition behind PB and DPB, it does not really illustrate the shortcomings of the two metrics. An exercise utilizing Figures 2 and 3 makes the shortcomings of the metrics very apparent. Allow the annual revenues for a project to be $250.00, $250.00, $250.00, and $100.00 while maintaining the $500.00 cost. The PB is 2 years and the DPB (assuming a 10% discount rate) is 2.35 years. Change the annual revenues to $210.00, $210.00, $210.00, and $5,000.00. For the second project, the PB is 2.38 years and the DPB is 2.85 years, which are both longer than the first project. Is the first project better than the second project? The instructor should make the student verbalize that both metrics do not necessarily consider all of the cash flows of the project. Notice, the $5,000.00 cash flow in the fourth year of the second project is completely ignored by both metrics.

To distinguish between the benefit of DPB over PB, add a third project that has the following annual revenues: $400.00, $100.00, $0.00, and $0.00. Notice the PB is 2 years just like the first project, but the DPB indicates that the cost is not recovered. Again, make the student verbalize why the third project is inferior to the other two projects.

Figure 3. The Discounted Payback Period in Excel with Interpolation

	A	B	C	D	E
1	Discount Rate:	10%			
2	Year 0:	Year 1:	Year 2:	Year 3:	Year 4:
3	-$500.00	$100.00	$200.00	$100.00	$400.00
4	Discounted Cash Flows:	$90.91[a]	$165.29[b]	$75.13[c]	$273.21[d]
5	Cost Recovery:	-$409.09[e]	-$243.80[f]	-$168.67	$104.54
6	Test Condition (Step 1):	1[g]	1[h]	1	0.617
7	Discounted Payback Period (Step 2):	3.617[i]			

[a]Cell Formula: =PV(B1,1,0,-B3)...the negative cash flow is to correct for Excel's default of all cash flows being negative.
[b]Cell Formula: =PV(B1,2,0,-C3)
[c]Cell Formula: =PV(B1,3,0,-D3)
[d]Cell Formula: =PV(B1,4,0,-E3)
[e]Cell Formula: = A3 + B4
[f]Cell Formula: = B5 + C4; Copy C5 to D5..E5
[g]Cell Formula: = IF(B5 <= 0, 1, IF(A3 > 0, 0,-A3/B4))
[h]Cell Formula: =IF(C5 <= 0, 1, IF(B5 > 0, 0, -B5/C4)); Copy C6 to D6..E6
[i]Cell Formula: =IF(E5 < 0, "COST NOT RECOVERED", SUM(B6:E6))

Further, allow the student to see why ignoring the time value of money is an important shortcoming for the PB metric.

The next portion of the lesson plan is to connect PB and DPB to the net present value (NPV) criteria based on the major shortcomings of the PB and DPB metrics: not all of the project cash flows are considered when calculating PB and DPB, and the time value of money is not considered when calculating PB.

THE CONNECTION BETWEEN PB, DPB, AND NPV (...and IRR)

The net present value (NPV) is calculated by subtracting the project's discounted costs from the project's discounted revenues. If the NPV ≥ 0, the project is considered viable. NPV satisfies the two shortcomings associated with PB and the one shortcoming associated with DPB. NPV differs from DPB and PB in that all of the cash flows are considered (i.e., CFs occuring beyond the payback period). Additionally, in contrast to PB, NPV recognizes that not only must the cost be recovered, but the project must also generate a return commensurate with its risk. Although DPB differs from PB in the same manner, NPV considers all of the cash flows, which is not the case with DPB because DPB only considers cash flows to the extent that costs are recovered with a return included. The manner in which NPV is connected to DPB is that the DPB is equal to the

Figure 4. NPV and the Discounted Payback Period in Excel with Interpolation

	A	B	C	D	E
1	Discount Rate:	10%			
2	Year 0:	Year 1:	Year 2:	Year 3:	Year 4:
3	-$500.00	$100.00	$200.00	$100.00	$400.00
4	Discounted Cash Flows:	$90.91	$165.29	$75.13	$273.21
5	Cost Recovery:	-$409.09	-$243.80	-$168.67	$104.54
6	Test Condition (Step 1):	1	1	1	0.617
7	Discounted Payback Period (Step 2):	3.617			
8	Net Present Value:	$104.54[a]			

Note: The formulas in Figure 4 are identical to those found in Figure 3 with the addition of the formula in cell B8.
[a]Cell Formula: = E5

life of the project if the NPV is zero and the DPB is less than the life of the project if the NPV is greater than zero.

Taking this process further, a comparison of the DPB relative to the life of the project is not a traditional interpretation of DPB despite the direct connection to NPV when viewed in this manner (i.e., DPB ≤ life of project equates to NPV ≥ 0). Most texts compare the DPB measure to an arbitrary length of time determined by the policies of the firm. If this is the case, the firm risks rejecting positive NPV projects in which it takes longer to recover costs. By comparing DPB to the life of the project, such mistakes are avoided. However, the criticism of DPB not considering all cash flows is still problematic.

The NPV calculation can readily be added to the previous Excel program as shown in Figure 4. To illustrate the fact that the NPV is zero when the DPB is equal to the life of the project, change the revenue cash flows to $137.50, $151.25, $166.38, and $183.01. Notice, the cost is recovered in exactly four years (note: there may be some rounding error).

For a more illustrative example, use the NPV calculation as a means of calculating the DPB. In other words, define DPB as the number of periods necessary to set the NPV to zero. Let a project cost $500.00 and provide annual revenues of $275.00, $302.50, $332.75, $366.03, and $402.63 respectively. Calculate the NPV (assuming a 10% annual discount rate) based on all of the cash flows. Assuming the NPV is greater than zero, reduce the project by one cash flow, until the NPV is zero. Figure 5 illustrates this process using Excel.

A new question arises: if the NPV is greater than zero, then what actual rate of return is received from the project? Notice, the NPV calculation can only reveal that there is a return on the project greater than the project's risk adjusted discount rate (assuming NPV > 0), but there is no direct calculation that reveals the magnitude of the additional rate of return.[1] The calculation desired is the internal rate of return (IRR) for the project. A more precise definition is the IRR is the discount rate that sets the NPV to zero. With DPB, the NPV calculation is reduced in cash flow until the NPV is zero. IRR is similar, except the discount rate (not the cash flows) is adjusted to set the NPV to zero.

To illustrate how to find the IRR using NPV, only a portion of the Figure 5 Excel spreadsheet is necessary (Figure 6). Adjust the discount rate in cell B1 until the NPV becomes zero (raise the discount rate when the NPV > 0 and lower the discount rate when the NPV < 0). The IRR for the project appears to be very large, between 55% (NPV = \$1.10) and 56% (NPV = -\$6.38). An interpolated value can be calculated:

$$55\% + \left[\frac{\$1.10 - \$0.00}{\$1.10 - (-\$6.38)}\right] * (56\% - 55\%) = 55.15\% \qquad (2)$$

The interpolated value is approximately correct and a precise value can be found using Excel's Goal Seek function. However, the purpose of the exercise is to demonstrate conceptually what IRR represents. In demonstrating how to find the IRR in the context of the NPV calculation, the student is able to understand that the IRR calculation encompasses all of the cash flows and that it is essentially the "actual" return on investing in the project (assuming reinvestment at the IRR; see next section for discussion). Further, when using the IRR as the discount rate, the DPB is equal to the life of the project. Thus, the discounted measures of project analysis: DPB, NPV, and IRR are all related. However, there is one more aspect to consider that affects the value of the project.

THE IMPLICIT REINVESTMENT ASSUMPTION OF NPV AND IRR (Optional Material)

When assessing the holding period return of an investment, all cash flows recognized by the investment are summed and are evaluated relative to the initial investment on an annual basis. Should these cash flows receive interest, the holding period return improves. For example, suppose one invests in a \$1,000.00 bond that has annual coupons of \$80.00 (i.e., an 8% annual yield) and then sells the bond for \$1,000.00 after receiving the fifth coupon. The investment costs \$1,000.00 initially and \$1,400.00 has been recognized over five years on the investment (sold the bond for \$1,000.00 and received five \$80.00 coupons; totaling to \$400.00). The annual holding period return is 6.96% and not the 8% annual yield on the bond. Why is it not 8% annually? Because to achieve an

Figure 5. Using NPV to Calculate DPB

	A	B	C	D	E	F
1	Discount Rate:	10%				
2	Cash Flows:					
3	Year 0:	Year 1:	Year 2:	Year 3:	Year 4:	Year 5:
4	-$500.00	$275.00	$302.50	$332.75	$366.03	$402.63
5	Discounted Cash Flows:					
6	Year 0:	Year 1:	Year 2:	Year 3:	Year 4:	Year 5:
7	-$500.00	$250.00[a]	$250.00[b]	$250.00[c]	$250.00[d]	$250.00[e]
8	NPV (Years 0 to 5):	$750.00[f]				
9	NPV (Years 0 to 4):	$500.00[g]				
10	NPV (Years 0 to 3):	$250.00[h]				
11	NPV (Years 0 to 2):	$0.00[i]	← DPB			

[a]Cell Formula: =PV(B1,1,0,-B4)...the negative cash flow is to correct for Excel's default of all cash flows being negative.
[b]Cell Formula: =PV(B1,2,0,-C4)
[c]Cell Formula: =PV(B1,3,0,-D4)
[d]Cell Formula: =PV(B1,4,0,-E4)
[e]Cell Formula: =PV(B1,5,0,-F4)
[f]Cell Formula: =SUM(A7:F7)
[g]Cell Formula: =SUM(A7:E7)
[h]Cell Formula: =SUM(A7:D7)
[i]Cell Formula: =SUM(A7:C7)

Figure 6. Using NPV to Calculate IRR

	A	B	C	D	E	F
1	Discount Rate:	10%				
2	Cash Flows:					
3	Year 0:	Year 1:	Year 2:	Year 3:	Year 4:	Year 5:
4	-$500.00	$275.00	$302.50	$332.75	$366.03	$402.63
5	Discounted Cash Flows:					
6	Year 0:	Year 1:	Year 2:	Year 3:	Year 4:	Year 5:
7	-$500.00	$250.00	$250.00	$250.00	$250.00	$250.00
8	NPV (Years 0 to 5):	$750.00				

Note: The formulas in Figure 6 are identical to those found in Figure 5 except cells B9..B11 have been eliminated.

8% annual return on the investment, the coupons must be invested at an 8% annual rate. This "reinvestment rate" for the coupons is crucial for improving the performance of the investment.

Projects are investments and when assessing the NPV or the IRR, there is an implicit assumption that reinvestment of the cash flows is occurring at a particular discount rate. We will call this assumption, the "reinvestment assumption". More specifically, the IRR method assumes that funds are reinvested at the IRR, and the NPV method (and DPB to some extent) assumes reinvestment at the project's discount rate. This concept is difficult to discuss at an intuitive level and an example will help clarify the importance of the reinvestment assumption.

Assume an initial cost for a project is $1,000.00 and the next five annual cash flows are: $500.00, $250.00, $300.00, $400.00, and $100.00 respectively. The IRR for these cash flows is 19.84%, but does the investor actually earn this rate of return? The answer is...it depends on what the investor does with the cash upon receipt. Assuming that the investor does not reinvest the cash flows, at the end of five years, the investor has $1,550.00 ($500.00 + $250.00 + $300.00 + $400.00 + $100.00). The holding period return on the project is well below the IRR:

$$\left(\frac{\$1,550.00}{\$1,000.00}\right)^{\frac{1}{5}} - 1 = 0.0916 = 9.16\% \tag{3}$$

The difference between the actual return (i.e., the holding period return) on the project and the IRR is due to the failure of the investor to reinvest funds when received.

Suppose the investor reinvested any money received at a 10% annual rate, how much wealth is available after five years?

$$\$500(1.10)^4 + \$250(1.10)^3 + \$300(1.10)^2 + \$400(1.10)^1 + \$100 = \$1,967.80 \tag{4}$$

At the end of five years, there is $1,967.80 available from investing in the project. The actual return earned on the project is:

$$\left(\frac{\$1,967.80}{\$1,000}\right)^{\frac{1}{5}} - 1 = 0.1450 = 14.50\% \tag{5}$$

This is superior to not reinvesting the funds at all, but still below the "expected" 19.84% annual return implied by the IRR. When will the investor actually receive a 19.84% return? The actual return will only equal the IRR when the investor reinvests the funds at the same rate as the IRR. To finish our example, assume our investor reinvests at 19.84% annually.

$$\$500(1.1984)^4 + \$250(1.1984)^3 + \$300(1.1984)^2 + \$400(1.1984)^1 + \$100 = \$2{,}471.76$$

The actual rate of return is equal to the IRR:

$$\left(\frac{\$2{,}471.76}{\$1{,}000}\right)^{\frac{1}{5}} - 1 = 0.1984 = 19.84\% \tag{6}$$

Finally, the investor is actually earning the IRR, but only after reinvesting the cash flows from the project at a rate equal to the IRR on an annual basis.[2]

The possible inability to reinvest at the IRR often leads one to surmise that NPV is a far superior methodology as it does not make the same assumption. However, NPV also has a similar implicit assumption.[3] NPV assumes reinvestment at the project's discount rate. Using the cash flows from the IRR example, the NPV (assuming a 10% discount rate) is $221.85. With no reinvestment, the investor has $1,550.00 at the end of five years. If we discount this back five years at 10 percent, the effective NPV is -$37.57 (this should not surprise us given equation (3)). With no reinvestment of the cash flows, this project is unacceptable. As shown in the IRR example (equation (4)), investing at 10% annually (the discount rate for the project) results in the investor having $1,967.80 at the end of five years. When discounted back five years, we again arrive at an NPV of $221.85.

Figure 7 illustrates the effects of the reinvestment assumption. When there is a reinvestment rate of zero, the "Reinvested CF" portion of the spreadsheet does not earn any interest. Consequently, the "True" return on the investment into the project is 9.16% (again, see equation (3)) which is below the discount rate for the project and the "True" NPV is less than zero (i.e. -$37.57). By increasing the reinvestment rate to 10%, the "true" NPV equals the traditional NPV calculation and by setting the reinvestment rate to 19.84%, the "True" return will be equal to the IRR.

Is there a way to account for the reinvestment assumption of NPV and IRR analysis? Yes, if we make the assumption of cash flows being reinvested at the cost of capital (say 9% in this example) and then perform calculations like that of equations (4) and (5) or within the template in Figure 7 by setting the reinvestment rate to 9%.

$$\$500(1.09)^4 + \$250(1.09)^3 + \$300(1.09)^2 + \$400(1.09)^1 + \$100 = \$1{,}921.98 \tag{7}$$

$$\left(\frac{\$1{,}921.98}{\$1{,}000}\right)^{\frac{1}{5}} - 1 = 0.1396 = 13.96\% \tag{8}$$

Figure 7. Calculating "True" Return and NPV

	A	B	C	D	E	F	G
1	Discount Rate:	10%					
2	Reinvestment rate:	0%					
3							
4	Cash Flows (CF):						
5	Year:	0	1	2	3	4	5
6	CF:	-$1,000.00	$500.00	$250.00	$300.00	$400.00	$100.00
7	Reinvested CF:		$500.00[a]	$250.00	$300.00	$400.00	$100.00
8	Sum of Reinvested CF:	$1,550.00[b]					
9	NPV:	$221.85[c]					
10	IRR:	19.84%[d]					
11	"True" NPV:	-$37.57[e]					
12	"True" Return:	9.16%[f]					

[a]Cell Formula: =C6*(1+B2)^(G5-C5); Copy C7 to D7..G7
[b]Cell Formula: =SUM(C7:G7)
[c]Cell Formula: =NPV(B1,C6:G6)+B6
[d]Cell Formula: =IRR(B6:G6)
[e]Cell Formula: =(B8/(1+B1)^G5)+B6
[f]Cell Formula: =((B8/-B6)^(1/G5)-1)

The 13.96% annual holding period return is called the modified internal rate of return or MIRR.[4] More specifically, the MIRR is the annual holding period return when all of the cash flows received are reinvested at the firm's cost of capital. The cash flows appreciate at the cost of capital and then the holding period return is calculated at the end of the project with the project's costs considered as the initial investment. Thus, the MIRR is the correction for the IRR.

If one discounts the result of equation (7) by the project's discount rate of 10% and then subtracts the project's cost of $1,000.00, a "corrected" NPV of $193.40 emerges. Notice the technique takes advantage of part of the MIRR calculation and portrays a more accurate assessment of the project. Further, if the cost of capital for the firm and the discount rate for the project are equal, the original NPV calculation of $221.85 is correct. Unfortunately, many texts make the assumption that risk and firm risk are equal and are not careful to articulate that the discount rate and the marginal cost of capital can be different. Consequently, students assume incorrectly that the discount rate and cost of capital are always the same. Generally, the two rates are only the same when the project is similar to a firm's existing production practices.

At a minimum, what the student takes away from this analysis is that when funds are received from an investment, such as a project, the funds need to be reinvested or the perceived value of the project using NPV or IRR dissipates. Mathematically, this is the result of the reinvestment assumption contained in the calculation of NPV and IRR. But more importantly, this is a very practical lesson for any business major to understand: funds should never lie idle! At this point, the lecturer can transition into a discussion about dividend policy (should "idle" cash go back to shareholders?) or topics involving cash management.

CONCLUSION

By demonstrating how PB, DPB, NPV, and IRR are related, the student gains an appreciation of all the merits and disadvantages of the different project evaluation metrics. The Excel component can be used to provide visual support to the lecture or can be incorporated wholly or partially as assignment material. The programming skills necessary for interpolated values become a valuable skill even outside of the context of finance (nested-IF statements appear in many contexts).

The latter portion of the paper discussing the reinvestment assumption can be brought into an introductory finance course at the lecturer's discretion. The opinion of the authors is that MBA students should be sophisticated enough to grasp the concept, but it may be better for undergraduate students to see the concept in a second corporate finance course rather than in an introductory course.

ENDNOTES

[1] Even though NPV does not show the actual rate of return earned in excess of the appropriate discount rate, NPV does show the magnitude of dollars earned in excess of the appropriate return due to risk. This dollar-based result meshes better with the principle of shareholder wealth maximization than many of the other capital budgeting techniques. For example, an NPV of $1,000,000 indicates that not only has an adequate return been earned relative to risk, but that investing in such a project would additionally place $1,000,000 in investors' pockets in today's terms.

[2] It is easily shown that by reinvesting at a rate of return greater than the IRR, the investor will actually earn a rate of return greater than the IRR.

[3] The reinvestment assumption of NPV is generally viewed as less restrictive than the reinvestment assumption of IRR as the project's discount rate is generally seen as a reasonable rate of return.

[4] This is not the same as the modified IRR concept contained in textbooks for correcting the situation of multiple IRRs.

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