14.8: Solutions to CH 8 Exercises

Question 1

1. The decision rule should consider all relevant cash flows
2. The decision rule should recognize the riskiness of the relevant cash flows
3. The decision rule should recognize the time value of money
4. The decision rule should rank the projects so that those projects that increase the firm's value the most are ranked the highest.

Note that rule four can not be shortened to rank projects. Any decision rule will rank the projects, but we want our "optimal" decision rule to rank by value added. Also, a decision rule that does not meet all four criteria is not necessarily worthless. Instead it means that it has some obvious flaws that must be recognized.

Question 2

The Payback Period

1. may not consider all relevant cash flows,
2. does not consider TVM,
3. does not rank by value added, and
4. has an arbitrary decision rule.

Consider each in order. First, consider two projects as follows:

	Project A	Project B
Year 0	-$100,000	-$100,000
Year 1	50,000	49,000
Year 2	50,000	49,000
Year 3	5,000	90,000

According to PP, we would prefer project A as it has a shorter PP. However, clearly Project B is superior. The problem is that we fail to consider any cash flows that come in after the PP. Now consider another two projects.

	Project A	Project B
Year 0	-$100,000	-$100,000
Year 1	98,000	1,000
Year 2	1,000	99,000
Year 3	75,000	75,000

According to PP, we would prefer project B as it has a shorter PP. However, Project A is superior (NPV_A = $41,681 vs. NPV_B = $33,199 when k=12%). The problem is that PP fails to recognize the advantage of getting $98,000 in year 1 as opposed to $99,000 in year 2. Because of TVM, the $98,000 is much more valuable. The third problem does not need an example. Our goal is to maximize value not get our initial investment back as soon as possible. Following PP distracts us from our primary goal and can lead to bad decision making. Finally, consider the arbitrary cutoff point. Lets say management chooses 3 years for the cutoff. What is special about 3 years vs. 2.5 or 3.5? Nothing really. There is no theoretical basis for any specific cutoff level.

The second part of the question is why bother with PP since it has so many flaws? The answer is twofold. First, one recent survey estimates that over 50% of firms (see Ch. 8) use PP either always or often in their capital budgeting process. Since so many firms use this decision rule, it is important to know how to calculate PP and what it is telling us. It is also important to know its flaws so we know its limitations as a decision rule. The second reason to know PP is that there are two specific situations where PP can be useful. One is for extremely risky projects where there is a significant chance that the project life will be shorter than anticipated. Under this scenario a quick payback may be critical. That way even if the firm has to kill the project early it may still be able to recover most (or all) of their costs. Two, firms that are extremely weak financially may pay extra attention to PP. If the project has a high NPV, but will not start generating positive cash flows for several years it may not be appropriate to firms in financial distress. They need projects that pay off quickly in order to stay in business.

Question 3

Yes, when projects are independent NPV and IRR will make the same accept/reject decision. The reason for this can be thought of mathematically or intuitively. Mathematically, IRR is the discount rate at which NPV is equal to zero. Any higher discount rate causes NPV to be less than zero and any lower discount rate would cause NPV to be positive. Thus at all positive NPVs, the IRR is higher than the required return and at all negative NPVs the IRR is lower than the required return. Intuitively we can consider that the IRR tells us the expected return on our initial investment. If the expected return is greater than the required return we should be adding value (and vice-versa). Thus, whenever the IRR is higher than the required return the NPV will be positive and whenever the IRR is less than the required return the NPV will be negative. Because IRR and NPV make the same accept reject decision, either can be used for independent projects. It is only for mutually exclusive projects where we will have problems due to different rankings of which project is best.

Question 4

The first two IRR problems are both ranking issues. One (the size problem) has to do with the initial investment sizes and the second (the reinvestment rate problem) has to do with cash flow timing issues. Before I go into explaining these problems, it is important to note that both are ONLY problems with mutually exclusive projects. For independent projects, they will alter the ranking of projects, but not the accept/reject decision and are therefore irrelevant. Let’s start with the size problem. If we must choose only one project from a list of projects, we want to make sure we select the one that adds the most to firm value. Typically it is easier to do this with a larger project. Consider the following two projects (both with a 15% required return):

	Project A	Project B
Year 0	-$10,000	-$100,000
Year 1	6,000	50,000
Year 2	6,000	50,000
Year 3	6,000	50,000
IRR	36.31%	23.38%
NPV	$3,699	$14,161

Project A looks better according to IRR and has a higher return. However, if we can choose only one, we’d rather earn a little lower percentage return on a lot larger investment. Project B will increase firm value by over $10,000 more than project A would. The difference in sizes for the initial investment leads to different rankings. The second ranking issue with IRR is the reinvestment rate problem. The calculation process of the IRR assumes that all intermediate cash flows will get to be reinvested at the IRR. For projects with high IRRs, this can distort the true return. For instance, in project A above, it assumes that we can reinvest each of the $6000 cash flows and earn over 36% on those investments. It is unlikely that we will be able to do so. This reinvestment rate problem shows up primarily in projects that have significantly different cash flow timing issues. For instance, front-loaded projects (where a large % of cash flows come in early) are more susceptible to the reinvestment rate problem than are back-loaded projects. Again, consider two projects (both with a 13% required return):

	Project A	Project B
Year 0	-$100,000	-$100,000
Year 1	80,000	0
Year 2	50,000	25,000
Year 3	20,000	160,000
IRR	30.20%	24.08%

NPV	$23,815	$30,467

According to IRR, Project A looks better but Project B increases firm value by around $7000 more than Project A. This is because the IRR calculation assumes that the $80,000 cash flow in year 1 will be reinvested at 30% for two years which is unlikely. Since most of the cash flows in Project B are at the end of the time, they are not greatly affected by the reinvestment rate assumption. We know that this problem is due to reinvestment and not size as the initial investments are the same, but the timing of cash flows is different.

The third IRR problem is relatively rare. It is referred to as the Multiple IRR (or Crossover) Problem and occurs when the cash flows change signs more than once. For each sign change (from negative to positive or from positive to negative) there will be a unique IRR. Therefore, for a project that has two sign changes (crossovers) there are two IRRs. Three crossovers mean 3 IRRs. When this happens, the IRR is unreliable and shouldn't be used.

The final issue is why know about IRR given its flaws? The answer is that it is commonly used in practice (more than 75% use IRR according to the survey mentioned in the Ch. 8). The reason it is so commonly used is twofold. First, it is easily understood. Since many people involved in capital budgeting may not be finance people it is important to be able to communicate the results in a manner that is easy to follow. Most people are comfortable with rate of return analysis and intuitively understand what a 25% IRR means. On the other hand, without some training fewer people understand a $3567 NPV. This in itself is not enough reason to use IRR – five minutes can explain the basic NPV framework. However, in most cases IRR is sufficient. As long as the projects are not mutually exclusive and there is no crossover problem, IRR and NPV will give the same results. So NPV is only needed when a problem exists.

Question 5

PP – increase T for low risk projects and decrease T for high risk projects.

IRR, NPV – decrease k for low risk projects and increase k for high risk projects.

Question 6

No, it does not mean the process is flawed. Capital budgeting analysis gives us a framework for analyzing the value of long-term investment projects. However, two important problems remain. First, the results can only be as good as the inputs into the calculations. If we don't have reasonable forecasts of the cash flows associated with a new project, the expected lifespan, and the risk involved, then the NPV analysis is not helpful. This would be a case of "Garbage In, Garbage Out." Our calculated values are only as good as our inputs. However, we can still have reasonable forecasts and bad results. Anytime we are forecasting future cash flows, we need to remember that they are only forecasts. If we KNEW the outcomes with certainty, life would be a lot easier (but much more boring). Any tool for making decisions about the future (such as NPV analysis) is going to include error. However, it is still useful. If we have a good process, we will be right more often than we are wrong. As an analogy, assume you must pick a basketball player to make one basket. Player A makes 90% of his shots and Player B makes 20%. If you pick Player A and he misses, does that mean you made a bad choice? No! Given the available information, IN THE LONG RUN, you will do far better by choosing Player A. However, in any specific trial, there is a large random factor. Judging your decision process based on short-term results is results-oriented thinking and can lead to a major problem. If we have a good process for estimating cash flows, project life, and risk, then NPV will allow us to accept projects that OVER TIME will add value to our firm. While we may have a few bad outcomes, the process will lead to us being right more than we are wrong.

Problem 1

PP_A = 2.89 years
PP_B = 3.26 years
PP_C = 2.33 years
PP_D = 3.39 years

IRR_A = 9.99%
IRR_B = 15.40%
IRR_C = 17.07%
IRR_D = 12.94%

NPV_A = -$71,051
NPV_B = $38,622
NPV_C = $28,259
NPV_D = -$14,437

If Independent

Choose Projects B and C as both have positive NPVs. While the PP exceeds T for project B, unless the company has significant financial problems and/or is severely concerned about the project lasting the four years. NPV is the best decision rule, so when the decision rules give conflicting results, go with NPV.

If Mutually Exclusive

Choose Project B as it has the highest NPV. The higher IRR for project C is irrelevant and is caused by the different sizes of the projects. Again, when there are conflicts among the rules always follow NPV.

Problem 2

We identify the size problem by looking for different initial investments. Projects AC, AD, BC, and BD all are pairs with different initial investments. However, we also want to find a pair of projects without the reinvestment rate problem. Since A and C are both frontloaded while B and D are both backloaded, they should not suffer from the reinvestment rate problem. Therefore, you could select either AC or BD as an answer for a pair of projects that could suffer from the size problem, but not the reinvestment rate problem.

When looking for pairs of projects that might suffer from the reinvestment rate problem, we have AB, AD, BC, and CD. However, we also want to find a pair of projects without the size problem. Since both AB and CD have the same initial investments, they will not suffer from the size problem. Therefore, you could select either AB or CD as an answer for a pair of projects that could suffer from the reinvestment rate problem, but not the size problem.