

NORTHWESTERN UNIVERSITY
J.L. KELLOGG GRADUATE SCHOOL OF MANAGEMENT

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Finance D30

Teaching Note: Project Cash Flow Analysis

Introduction

We have discussed applying the discounted cash flow framework to the valuation of investments in real assets (capital budgeting projects) and have discussed using the different decision rules (NPV, IRR, PI, etc.) to select capital investments. In this note, we will confine our discussion to decisions made using the net present value rule. Our model for determining the present value, NPV_0 , of the an investment generating cash flows of CF_t , $t = 0,1,\dots,N$ is:

$$NPV_0 = \sum_{t=0}^N \frac{CF_t}{(1+r)^t} \quad (1)$$

where CF_t is the total cash flow generated by the project at date t , r is the opportunity cost of capital for the investment project (assumed to be the same for all t) and $1/(1+r)^t$ is the present value factor used to discount the cash flow at time t back to the present. Equation (1) summarizes the basic principles of the discounted cash flow (DCF) method of estimating value:

1. It is **cash flow** that matters, i.e., the timing and magnitude of the cash flows of the investment are what is relevant.
2. **All** the future cash flows of an investment are relevant, not just the near term. **Long term.**
3. The present value of the future cash flows discounts each cash flow by its **opportunity cost of capital**, i.e., the expected rate of return the shareholders could earn if they invested in securities in the capital market with similar characteristics, especially **risk**.

The purpose of this teaching note is to discuss how to estimate the cash flows of the investment. To

focus on this aspect of the problem, we will assume away some complications: first, we will not discuss estimating the opportunity cost of capital or the riskiness of the investment. These tasks are deferred to Chapters 7-9 of Brealey and Myers. In fact, we will implicitly assume there is no risk in the future cash flows --- that they are known with certainty.¹ Second, we will assume there are no important term structure effects; i.e., r will be the same for all future dates, t . We have covered how the term structure of interest rates affects present values in the teaching note, "Bond Valuation under Certainty."

Valuation of corporate cash flows is an application of our "neat and clean" valuation methodology which runs head on into two disciplines which are very "messy": accounting principles and tax requirements. In finance, we often treat these areas like "necessary evils," but mastering some aspects of both areas is a prerequisite for making good investment decisions in practice. Understanding accounting principles is important because often the source of information used to generate the cash flow forecasts is derived from the project's effect on the accounting statements of the company (e.g., the income statement). Understanding relevant aspects of the tax code is crucial, because, as we shall see below, all cash flows should be estimated on an after-tax basis. The tax treatment of many items in cash flow analysis will affect the timing and magnitude of the tax liabilities associated with an investment, hence affecting its net present value.

While the "necessary evils" of generally accepted accounting principles and the tax treatment of cash flow components are important, it is beyond the scope of this note and, thankfully, this course to cover these

¹The assumption of perfect certainty has several impacts on our analysis of capital budgeting: first, many of the issues we will deal with below, e.g., the treatment of cannibalization, will be overly simplified because we will assume the existence of and the amount of cannibalization of other product lines is known with certainty. Addressing such issues in the context of uncertainty is dealt with not only in Chapter 9, but also in Chapter 10 which discusses sensitivity analysis and decision tree analysis. These issues are beyond the scope of this note. Assuming perfect certainty also eliminates from consideration the value of managerial options, e.g., the option to expand capacity *if the project does well*, or to abandon early *if the project does poorly*. Managerial options may be important, if not crucial, to the value of capital budgeting project. The *value* of these options derives from their contingent nature: they are only exercised if it is in the shareholders' interest, and this depends on something which is, from today's perspective, random. In a certainty model, we know when and whether the "options" will be exercised and what they are worth. Chapter 20 introduces methods for valuing contingent claims and Chapter 21 applies these methods to capital budgeting problems.

areas in detail. Hopefully, we will show some important differences between some accounting variables and cash flow and how these and taxes affect the value of capital budgeting projects. Our treatment of accounting and taxes will be shamelessly simplistic, however, so that we can focus on the finance instead.²

What we intend to do is flesh out what we mean by the "total cash flow generated by the project" at each date $t, t=0,1,\dots,N$. There are three important concepts in estimating the cash flows for an investment.

1. Only cash flow is relevant.
2. Only incremental cash flow is relevant.
3. Be consistent in treatment of inflation.

Once we have determined which cash flows are incremental to the investment, we must estimate the cash flows on the correct basis. The relevant cash flow generated by the project at date t is the **Operating Free Cash Flow** at date t . We will take these concepts up in turn, and then we will present general formulas for calculating the project's Operating Free Cash Flow for each period, t , of the project's life.

Only cash flow is relevant.

The fundamental component of the discounted cash flow framework is *cash flow*. It is the cash flow impact of a decision that matters, not its effect on earnings *per se*. This used to be the distinguishing mark of the finance field versus the accounting profession: accountants placed the corporate focus on earnings variables such as EPS and ROE, while finance argued the focus for decision-making should be on cash flow. Cost accounting was the first field which jumped ship, and most cost accounting texts handle the capital budgeting problem in a fashion indistinguishable from ours. In the late '70's and early '80's came what some call the "shareholder value revolution," which saw the birth of several firms (e.g., Stern-Stewart, Alcar, HOLT) using discounted cash flow valuation methods for estimating corporate value, for evaluating the shareholder value impact of changes in financial and operating strategies, in evaluating mergers and

²Tax rules and accounting regulations change relatively frequently as well, whereas financial principles do not. The interested student is directed to the Kieso and Weygandt text and the U.S. Master Tax Guide, for the most recent year.

acquisitions, and evaluating corporate restructuring alternatives. Most large accounting/consulting firms and strategy consulting firms have departments which specialize in some aspect of using discounted cash flow methods to analyze corporate decisions. In 1987, the FASB required companies complete a new financial statement called the statement of cash flows.³

Depreciation is not a cash flow.

To illustrate the difference between cash flow vs. accounting income treatments of cash flow items, consider the immediate purchase of capital equipment for \$10,000. The cash flow impact of the investment is -\$10,000 at time zero. The income statement does not recognize this investment as a current expense, but instead *depreciates* the asset over time. The annual depreciation amounts are subject to GAAP rules. If we assume the asset is depreciated straight line over five years to zero estimated salvage value, the annual depreciation is $(\$10,000 - 0)/5 = \$2,000$ per year in years one through five. The cash flow recognition of the initial cash outlay is the relevant measure to use to assess the economic cost of the equipment. The annual depreciation amounts are not, in and of themselves, cash flows at all. As we will see below, the \$10,000 will not be tax deductible immediately; instead, the expenditure will allow for tax reductions (or tax shields) in later periods when it is depreciated. It is important to note, however, that the relevant depreciation for capital budgeting purposes is the depreciation that is allowed *for tax purposes*, not that allowed for *reporting purposes*.

Timing of recognition of revenue and expense: working capital

For most corporations, accounting for reporting purposes is done on an accrual basis: revenue from

³The major place where cash flow seems to take a back seat to earnings is in the financial analyst community and how corporations communicate with this community. There remains a ludicrous focus on quarterly and annual EPS and ROE by both analysts and CFO's which doubtless leads to many value-reducing decisions, but that is beyond the scope of this note also. The interested reader is directed to the Copeland, Koller and Murrin book and the Rappaport book.

sales of goods is recognized when the sale takes place, not when the cash is received for the sale. Expenses are matched against revenues: if you purchase materials (suppose you pay cash) which go into the production of a finished product and the product has not been sold at the end of the year, there is no recognition of the expense for reporting purposes. In the following year, when the finished product is sold, you recognize the cost of the earlier purchases in Costs of Goods Sold.

From a cash flow perspective, we would like to record the sales revenue when we receive the cash and would like to record the expense of the purchases when we pay cash for them. Because, however, we will often use the income statement as the starting point in our analysis of cash flows, we will time the above revenue "too early" and the expense "too late." As an example, suppose we sell \$100,000 of widgets in 19X2 which are still in accounts receivable (a current asset) at the end of the year (assume the receivables are good); 19X2 revenue will include the \$100,000, and accounts receivable will include the \$100,000. In 19X3, the \$100,000 will not be revenue and accounts receivable will drop by \$100,000 as we receive the cash. If there were no other changes in the accounts receivable account during 19X2 and 19X3, we could calculate the cash revenue (associated with the \$100,000) in 19X2 and 19X3 by the following:

$$\begin{aligned}\text{Cash revenue (19X2)} &= \text{Sales (19X2)} - \text{Chg. in Accounts Receivable (19X2)} = \$100,000 - \$100,000 \\ &= 0\end{aligned}$$

$$\begin{aligned}\text{Cash revenue (19X3)} &= \text{Sales (19X3)} - \text{Chg. in Accounts Receivable (19X3)} = 0 + \$100,000 = \\ &= \$100,000\end{aligned}$$

Notice *the increase in the current asset, accounts receivable, is considered a cash outflow, or an investment.*

Similarly, if we purchased \$50,000 in raw materials in cash at the end of 19X2 and did not sell any products against which to match these expenses in 19X2, we would have an increase in inventory (a current asset) in 19X2 and no expense in 19X2. If there were no other changes in inventory in 19X3, and the subsequent sales are made, we will have \$50,000 in expenses in 19X3 and a reduction in inventory of \$50,000 in 19X3. Using the above analysis:

Cash expense (19X2) = Expense (19X2) - Chg. in Inventory (19X2) = \$0 - \$50,000 = -\$50,000

Cash expense (19X3) = Expense (19X3) - Chg. in Inventory (19X3) = -\$50,000 + \$50,000 = \$0

Notice, again, the increase in inventory is considered an investment or cash outflow.

Timing differences between the recognition of income and receipt of cash flow is incorporated into the required net working capital for the project. Net working capital is defined as current assets minus current liabilities. Current asset accounts include cash, marketable securities, inventories, accounts receivable, and others. Current liabilities are liabilities of the firm which will come due within one year and include accounts payable, short-term debt, current portions of long-term debt, income taxes payable, and others. To simplify the discussion, we will consider net working capital to be Cash and Marketable Securities + Inventories + Accounts Receivable - Accounts Payable.

Increases in net working capital are cash outflows (investments) and decreases in net working capital are cash inflows.⁴ Cash which must be left available for unexpected expenditures, inventories which must be built up for expected growth and to avoid *stockouts*, receivables which are used to facilitate trade represent uses of cash that could be used elsewhere in the firm (or spent by the shareholders, perish the thought) and are correctly considered investments made by the firm. These increases in current assets will usually be partially offset by corresponding increases in accounts payable, which reduces the size of the investment.

A complete capital budgeting analysis would forecast the cash required, the future accounts receivable and accounts payable, and inventory requirements over the life of the investment project. The purpose of any forecasting analysis is to generate forecasts which are as accurate as possible.⁵ The

⁴Notice that, in both examples, the increase (decrease) in current assets seems to have been offset by a decrease (increase) in cash: when the receivables are paid, cash goes up, when the inventory is paid for, cash goes down. The assumption we make is the the operating level of the cash account is maintained as protection against unexpected cash requirements. When the cash is drawn down, it must be replenished to its earlier level and when we get "excess cash," it is invested elsewhere and is not in the "operating cash account." For practical purposes, the operating cash account increases and decreases only due to the need for a larger or smaller protective cash account.

⁵Actually, this depends on the loss function associated with forecasting errors. Discussion of loss functions is beyond the scope of this note.

appropriate model for forecasting accounts receivable may be to calculate the past percentage of accounts receivables to sales and assume that ratio will remain constant in the future. Of course, if the product is sufficiently different than your other products, this may not be the case. Similarly, if you begin making different credit terms available to your customers, the relationship between accounts receivable and sales may change. Similarly, you could model payables and inventories separately. The one general point which can be made is that most of the net working capital categories increase with the scale of the firm, i.e., as sales increase, operating net working capital increases. For capital budgeting projects which are revenue expanding projects, there will be an increase in net working capital at the beginning of the project; as the project's sales grow during its lifetime, additional net working capital will be needed; as the project matures and its sales level off, additional net working capital investments will be less necessary or unnecessary; and as the project declines, working capital requirements taper off. If the project has a natural ending date, it can be assumed that you could sell the remaining inventory, the remaining accounts receivable and payable are settled and the need for operating cash goes to zero. Therefore, if we forecast an ending date or termination date for the investment, we normally assume that earlier investments in working capital can be *recovered* at that time. See the discussion about termination of projects below.

Incremental Cash Flows

The most important concept in cash flow analysis is that the relevant cash flows for decision making are the *incremental cash flows* the project generates. The critical comparison to make is the "with versus without" distinction: is the cash flow incurred with the new project, and would the cash flow have been incurred without the new project? If the cash flow will be incurred with the new project and otherwise would not have been incurred, it is an incremental cash flow and should be included in the analysis.

Omit sunk costs.

Expenditures which were made in the past such as research and development expenditures, test marketing expenses, even capital expenditures which have been made prior to the analysis, are not incremental to the current decision. They can not be "unincurred": if the project has a positive NPV ignoring these costs, taking the project would still make you wealthier than you are now; if the project has a negative NPV ignoring these costs, taking the project will make you less wealthy than you are now --- the prior investment is already gone.⁶

The fact that managers make mistakes such as the sunk cost fallacy is not surprising. While we assume that the goal of the firm is always to maximize the net present value of all the firm's activities, assuming this does not make it so. Decision makers (e.g., the CEO or divisional managers) may have significant human capital riding on a particular project and it is natural for them to view the project from its effect on them rather than on the shareholders. The abandonment of an investment that has already cost a lot of money may be equivalent to admitting failure. Brealey and Myers have a good example of the sunk cost fallacy at work in the Lockheed Tri-Star case. An equally startling example was the "smokeless cigarette," which was a pet project of RJR-Nabisco's CEO Ross Johnson: RJR had spent millions for years in research and development despite marketing research that strongly suggested that no one would ever use it. When RJR was taken private, one of the first items of waste that was eliminated was investment funds directed towards this project.⁷

Include opportunity costs.

⁶Most principles in finance are just warmed over epithets from grandmothers everywhere. We have seen "a penny saved is a penny earned" and "a stitch in time becomes nine." The sunk cost principle is simply says "There's no use crying over spilled milk" or "Let bygones be bygones." Similarly, we could say "Don't throw good money after bad," but I don't think my grandmother ever sounded that mercenary. Later, we will revisit grandmothers for advice concerning the optimal transportation of eggs.

⁷Interested readers are directed to *Barbarians at the Gate*, by Bryan Burrough and John Helyan. Or if you are lazy, you can rent the movie.

One of the most difficult aspects of capital budgeting is the fact that so many resources within a company are shared across different projects. A new project will make use of existing plant space or will require construction on land that the firm already owns. A new product can be packaged on existing packaging equipment which has slack capacity. Each of these situations involves the firm incurring some opportunity cost: the opportunity cost in any of these situations is the loss of being able to use the resource in question in its next best alternative. The reason that these opportunity costs are "difficult" is that the cost is difficult to measure. Sometimes the cost is reasonably easy to estimate: suppose you have office space in an office building for your consulting firm and have some excess space currently. You are considering using some of the excess space to put in a state-of-the-art education facility. The space is currently being rented by you and would be rented by you with the project, but the with vs. without distinction requires an estimate of the opportunity cost of the space. If the space could be separated such that the office building could rent it to another tenant, then the opportunity cost would be the rental reduction you could get (net of costs) if you did not build the classroom. You have to be careful: if you do not build the classroom, supposedly you will have to use an off-site classroom and you will have to rent these facilities as needed. The point of this example was not to outline the entire cash flow analysis but to identify the opportunity cost of the space.

More generally, the opportunity cost of using excess capacity or space can be viewed as an application of the *cost of excess capacity* method, discussed in Brealey and Myers, Section 6-3. It should be pointed out that there may be opportunity benefits as well as costs: if a new investment requires the purchase of plant and equipment which, because of the minimum economic scale of the plant and equipment, involves substantial slack capacity, this capacity is then available for later investments to use. If this allows the firm to speed up growth opportunities or follow-up investments, a measure of the opportunity benefits should be included also. .

The relevant amount of overhead costs for the new investment are the incremental amount, not the allocated

amount.

The opportunity costs discussed above, while difficult to estimate, are at least situations where there are identifiable assets used by the new project. More generally, overhead expenses associated with all projects, such as general and administrative costs, CEO and secretary salaries, insurance and others are simply *overhead*. Overhead costs may not be related to any particular project but must be paid for in aggregate for the firm to be profitable. Overhead expenses are totalled and allocated across the different projects in the cost accounting process for assessment of the subsequent performance of the different projects. The allocation method used may be based on square footage used, or direct labor, direct materials, or whatever.

For capital budgeting purposes, a project should not be "charged" for *allocated* overhead, but should be charged for its incremental effect on overhead expenses. Because overhead expenses are not related to a specific project, it may be impossible to estimate the precise incremental effect of a new project on overhead expenses. A rule of thumb is that overhead expenses tend to be positively associated with the scale of the firm. If a project is revenue expanding there will be, on average, an increase in overhead expenses. The relationship between sales and overhead costs may be estimated using past data by regression methods.⁸ In contrast, if the project is purely cost reducing, e.g., the replacement of old machinery with new that has no effect on the scale of the firm, it may have no effect on the total overhead costs of the firm.

This issue could be looked at as another application of the cost of excess capacity method, but because there is little direct relation between the project and the usage of shared resources, it may be impossible to estimate via this method.

Include incidental effects: synergies, cannibalization, etc.

⁸See any cost accounting textbook for information on using regression analysis to estimate these relationships.

Often making a new investment has significant effects on other ongoing projects of the firm (and projects the firm has not begun yet). These interactions between projects should be taken into account in estimating the incremental cash flow for the new investment. Brealey and Myers discuss an example of a railway company considering building a new station connecting a new branch line to its existing rail system. They argue that they should not only include the direct revenue of rail traffic on the new branch line, but also the revenue associated with the incremental traffic on the rest of their railway system due to the branch line. The latter incremental revenue can be considered a **synergy** between the old rail assets and the new rail assets. Two sets of assets, A and B, are said to have synergies if the value of A and B together is different than the value of A by itself (as a *stand alone* business) plus the value of B by itself (as a stand alone business). The value of synergies can be positive (as in the railway example) or can be negative.

Product cannibalization is an example of a negative incidental effect. It is often argued that if an automobile company introduces a new model of car, that it will erode (cannibalize) the sales of their other models. Similarly, if Kraft introduces a new cheeze product it will take away some of the demand for Kraft Singles or other cheeze products that Kraft makes. If there is cannibalization of sales of other products due to the introduction of the new project, these should be taken into consideration in determining the incremental cash flows for the new investment. The following example illustrates some of the issues involved in estimating product cannibalization.

Example: You are the divisional manager of high-fiber cereals at a large cereal producer. Upper management wants to take advantage of perceived increase in demand for high-fiber cereals. You have put together a product proposal for Hemp Squares, a very high fiber cereal. For simplicity's sake we consider only revenues in the following discussion, but the same concept would apply to costs, etc. You have forecast annual revenues of \$500,000 for Hemp Squares. The divisional manager of the high-sugar cereals argues that this figure overstates incremental revenues for Hemp Squares because his division's other products (especially their big seller, Sugar Shells) will lose approximately \$70,000 per year in revenues to people switching to Hemp Squares. What is the correct estimate of incremental revenue for the Hemp Squares project, \$500,000 or \$430,000?

The answer to this question is based on the with versus without distinction. If they produce Hemp Squares,

they believe that their other products (especially Sugar Shells) will lose \$70,000 in sales. But, *if they do not* produce Hemp Squares, what will their lost sales of their other products be? In other words, what is the real cause of the decline in sales of the other products, your company's introduction of Hemp Squares, or a shift in demand of consumers wanting to buy high-fiber cereals (or some other reason)?

The question of how much cannibalization is relevant for capital budgeting purposes is integrally related to the market structure of the industry in which the firm operates. If the firm is completely competitive in this market and consumers have no loyalty to brand names or company names, then another competitor could be expected to produce the new product if you don't, and you would lose the sales anyway. Even if consumers do exhibit brand loyalty (which gives the firm some latitude relative to the competition), it is not clear that new product introductions will cannibalize other product lines. In the Hemp Squares example, the demand for high fiber cereals is probably what is driving the revenue forecasts for Hemp Squares; these customers will stop buying Sugar Shells anyway. If you don't produce Hemp Squares, they will buy the competition's Bran Bombs. If your division makes other high fiber cereals and consumers do exhibit some brand loyalty to your company (which is questionable too), then there probably will be cannibalization of sales of other similar high-fiber cereals.

If the product you produce is a commodity product like wheat, what is the likelihood that you will cannibalize sales? Suppose you are a wheat farmer with 1,000 acres on which you grow wheat and are considering purchasing 500 more acres to increase your crop size. Should you consider that customers buying your new crop's wheat will be taking away sales of your old crop's wheat? If we were talking about an island economy where you controlled the bulk of the wheat output of the nation, maybe. Chances are this is a tiny amount of the world supply of wheat and you won't affect the price you will receive for wheat. Cannibalization is zero in this example.

Suppose you are a business supply company and you carry a wide array of paper fasteners, paper clips, and the like, but you don't sell any staples or staplers. If you invest in inventory of staples and staplers

to sell also, should you consider the possible lost sales of other paper fasteners, papers clips, etc.? What is the likelihood that your clients were going without stapling documents that needed stapling? They were probably just buying staples and staplers elsewhere. Offering staples and staplers in your product line will just give your customers the chance to buy staples and staplers from you instead of somewhere else. Probably no cannibalization.

Automobiles and other consumer durables, etc., however, may be quite different. People exhibit considerable company-brand loyalty in car purchases. If Toyota decides to introduce a new sedan between the size of the Corolla and the Camry, it will probably take some sales away from Corollas and Camry's.

The bottom line is that cannibalization and other synergies are often difficult to estimate exactly, but the rule to use is the with versus without rule.

Do not include financing cash flows in your cash flows

Suppose you make a \$5 million investment in building a new store to add to your chain of stores. The investment funds are raised via a bank loan of \$5 million at 8% interest per year. Should your future cash flow forecasts include a deduction for $.08(\$5 \text{ million}) = \$40,000$ per year in interest expenses? Is the interest expense incremental? In a sense, yes. You take out the loan to build the new store and had you not built the new store, let's suppose you would not have borrowed any additional money. The interest expense seems to be incremental to the project. Why do we say *not* to include the financing cash flows in your cash flow forecasts?

Because including financing cash flows would be double counting. In equation (1), we discount the future cash flows to the project by the opportunity cost of capital on the investment. The opportunity cost of capital includes all costs associated with raising the entire investment amount: all interest and principal repayments on borrowings, all dividends and returns of capital to equity contributors. Therefore, the value

of the investment should be determined by discounting the incremental *operating* cash flows on the investment at the opportunity cost of capital for the investment.^{9, 10}

Be consistent in your treatment of inflation

If your forecasted cash flows have not incorporated anticipated future inflation or have already had it removed (i.e., they are inflation adjusted), then they are real cash flows and should be discounted at a real discount rate. If your forecasted cash flows incorporate anticipated future inflation, then they are nominal dollars and should be discounted at a nominal discount rate.

Formulas for calculating a project’s Operating Free Cash Flows

We begin with a typical income statement approach and modify it to estimate the cash flows of an investment. In every year of the project’s life ($t = 0, 1, \dots, N$), we could estimate the incremental effect of the project on the company’s income statement --- we have to be careful, we are talking about the income statement for *tax purposes, not for reporting purposes*. The income statement in year t , ($t=0, \dots, N$), would look like this:

$$\begin{array}{r} \text{Revenues}_t \\ \text{minus } \underline{\text{Costs of Goods Sold}_t} \\ \text{Gross Profit}_t \end{array}$$

⁹It will never be said that the language of finance is very clear. When I use the term *operating* cash flows, it is to distinguish them from *financing* cash flows, such as interest, principal, dividends, etc. "Operating" cash flows is often used to distinguish between the cash flows resulting from the operations of assets in place and "Investment" cash flows resulting from buying new assets. Both "Operating" and "Investment" cash flows are *operating* cash flows for our purposes because they are not financing cash flows. An alternative term could be to call operating cash flows *asset* cash flows, in that they are generated by asset decisions and not by financing decisions.

¹⁰We are assuming that the opportunity cost of capital incorporates all costs of financing the assets in question and, in essence, that the opportunity cost of capital is not a function of *how the assets are financed*. In Chapter 17, we will see that this assumption is equivalent to assuming the Modigliani-Miller Propositions are true, which is not so palatable in practice. Modifying our analysis to take into account the effect of financing decisions on the NPV analysis is the subject of Chapter 19.

minus	Depreciation _t	(depreciation may be included in Costs of Goods Sold)
minus	Other Operating Expenses _t	
minus	<u>Interest Expense</u> _t	(or other financing expenses)
	Profit before Tax _t	
minus	<u>Tax</u> _t	(actual tax going to Bill and Hilary)
	Net Income _t	

The income statement for year t does not capture our definition of cash flow: it subtracts out financing charges such as Interest Expense_t (effectively on an after tax basis) when we should leave that in. It subtracts out Depreciation_t as if it were a cash flow, which it is not. It correctly takes into account the tax shield associated with the Depreciation expense. Notice that I have separated the Depreciation line out so the reader can see that it is there; depreciation is often just included in Costs of Goods Sold_t. Lastly, it does not subtract off capital expenditures, CAPEX_t, when they occur, nor does it incorporate the changes in net working capital, ΔNWC_t , that are required to take on the new investment.

How do we modify the above income statement to calculate the project's cash flow correctly? We must add back Interest Expense_t to Profit Before Tax_t to get **Operating Profit before Tax_t**. Then we would multiply Operating Profit Before Tax_t by the effective tax rate of the company (which would be calculated as Tax_t/Profit before Tax_t) to get **Adjusted Taxes_t** (often called Cash Taxes). Then we subtract Adjusted Taxes_t from Operating Profit before Tax_t to get **Net Operating Profit Less Adjusted Taxes_t**, which goes by the appetizing acronym NOPLAT_t (although I don't think it's pronounced like the yogurt). Lastly, we add back Depreciation_t because it is not a cash outflow (but leave its tax shield effect in the tax account) and subtract off any incremental CAPEX_t required in year t and any incremental change in net working capital in year t . Our operating cash flow statement in year t becomes:

	Revenues _t	
minus	<u>Costs of Goods Sold</u> _t	
	Gross Profit _t	
minus	Depreciation _t	
minus	<u>Other Operating Expense</u> _t	
	Operating Profit before Tax _t	(We left out financing charges.)

minus	<u>Adjusted Taxes</u> _t	(Effective tax rate times Op Prof
bef Tax)		
	Net Operating Profit Less Adjusted Taxes _t	(NOPLAT _t)
plus	Depreciation Expense _t	(Add back non-cash charges.)
minus	Capital Expenditures _t	(CAPEX _t)
minus	<u>Change in Net Working Capital</u> _t	(ΔNWC _t)
equals	Free Cash Flow from Operations _t	(Op. FCF _t)

Example of calculating Free Cash Flow from Operations_t¹¹

Suppose a steel company is considering adding a new blast furnace to its operations. You have just completed a \$1 M feasibility study and have found the following: adding the blast furnace will result in \$50 M in new sales per year and will save \$90 M per year in expenses. Suppose that the furnace costs \$1,000 M (to be paid in advance) and uses some parts from a (fully depreciated) retired furnace. Removing the parts will render the old furnace worthless; otherwise, the old furnace could be sold for \$30 M. The furnace will last ten years, but you will have to invest \$200 M in replacement parts in year 5. Assume the replacement parts can be depreciated five years straight line to a zero estimated salvage value. The blast furnace (including the replacement parts) will have a salvage value of \$200 M at the end of ten years. Finally, you estimate that the company requires \$.40 in additional net working capital for every dollar of incremental sales.¹²

Suppose the firm uses straight-line depreciation for tax purposes and depreciates the blast furnace investment over a 10 year life to a zero estimated salvage (notice the estimated salvage for tax purposes is different than the true expected salvage value of the furnace) and pays 50% in corporate taxes. Lastly suppose

¹¹I thank Bob Korajczyk for the numerical example.

¹²"Incremental," in this context, means "the change from year to year," i.e., Incremental sales in year $t = \text{Sales}_t - \text{Sales}_{t-1}$. In our example, if the first year of sales using the new blast furnace is year 1, then incremental sales in year 1 would be \$50 M. In every subsequent year, since sales are *not changing*, incremental sales is zero. If the project terminates at year 10, then incremental sales in year 11 would be -\$50 M. Be careful, in capital budgeting analyses, "incremental" generally means "with vs. without."

that the firm will borrow half the investment funds \$500 M via a ten-year public bond issue on which they must pay annual interest payments of \$80 M and must pay the last annual interest payment and repay the full principal at the end of ten years.

Let's construct our free cash flows. Do you think the cash flows, as stated, are nominal or real? It's not clear by the above text. We will assume all cash flows discussed above are nominal cash flows, then after we calculate the Free Cash Flow from Operations in each year of the project, we will revisit this issue.

At time zero, we have to pay for the blast furnace, -\$1,000 M, a capital expenditure; we lose the after-tax opportunity cost of selling the old blast furnace, $-\$30 \text{ M}(1-.50) = -\15 M , and if we assume the company must have its incremental net working capital on hand at the beginning of the first year, $-.4(\$50 \text{ M}) = -\20 M . If we assume the annual cash flows from the operations of the blast furnace occur at the end of years 1 to 10, we have estimated the Free Cash Flow from Operations for $t=0$ to be $-\$1035 \text{ M}$. Notice we omit the sunk cost of the feasibility study. See the Table 1 on the next page. Other points to notice on Table 1:

Table 1. Blast furnace capital budgeting analysis, part I. (All amounts are in millions.)											
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Revenues		50	50	50	50	50	50	50	50	50	50
-Costs of Goods Sold		-90	-90	-90	-90	-90	-90	-90	-90	-90	-90
Gross Profit		140	140	140	140	140	140	140	140	140	140
-Depreciation		100	100	100	100	100	140	140	140	140	140
-Other Op Exp		0	0	0	0	0	0	0	0	0	0
Operating Profit before Tax		40	40	40	40	40	0	0	0	0	0
-Tax		20	20	20	20	20	0	0	0	0	0
Net Operating Profit after Tax		20	20	20	20	20	0	0	0	0	0
Add back Depreciation		100	100	100	100	100	140	140	140	140	140
Less CAPEX	1000					200					
Less Chg. Net Working Capital	20										20
Salvage value after tax	-15										100
Free Cash Flow from Operations	-1,035	120	120	120	120	-80	140	140	140	140	220

1. The annual incremental revenue is \$50 M, the annual cost savings is \$90 M, giving an incremental gross profit of \$140 M per year.
2. The annual depreciation in years 1 - 5 is 100M, which is the annual depreciation on the original \$1,000M purchase of the blast furnace: $(1,000M - 0)/10 = 100$ M. In years 6 - 10, the annual depreciation is the depreciation on the original blast furnace *plus* the additional depreciation on the replacement parts purchased in year 5. The latter annual depreciation is $(200M - 0)/5 = 40$ M per year. So the total depreciation in years 6 - 10 is 140 M per year.
3. Operating Profit before Tax is Gross Profit minus Depreciation minus Other Operating Expenses. Tax is .5 times Operating Profit before Tax.
4. Depreciation is a tax deductible expense, so it is taken out in the calculation of Operating Profit before Tax; in that way the tax line incorporates the depreciation tax shield. But depreciation is not a cash expense, so it must be added back.
5. Notice that the financing cash flows are omitted. Where the \$1,035 M comes from is not the issue. The future interest and principal payments on the debt, as well as the future payments to equityholders are not considered in the cash flows. The entire cost of financing the investment is *incorporated via the discount rate*, which is the opportunity cost of capital. If this investment could earn a risk-adjusted expected rate of return (via the CAPM or APT, or other model) of 10%, then investors will not want to invest in this project if the present value of its future expected cash flows (at 10%) is less than \$1035. We assume that the opportunity cost of capital, r , is *independent* of financial structure of the firm.
6. In year 5, we have to make \$200 M in additional capital expenditures, which are treated the same way as the initial capital expenditure of \$1,000M. It is important to note that the \$200 M is not an *expense*. If we could expense the replacement parts we would, because we would reduce taxable income by \$200 M immediately at time 5 rather than recognize the expense as \$40 M per year for

five years. From a cash flow perspective, the \$200 M is a cash outflow at time 5, but is tax deductible via its depreciation in years 6 - 10.

7. At the end of ten years, we are assuming we will terminate the investment. At that time (you could assume the termination cash flows take place in Year 11 if that is more realistic) we can sell the blast furnace for \$200 M, which will be fully taxable (because the basis of the furnace and replacement parts will be zero), so the after tax salvage proceeds is $\$200 \text{ M} - (200\text{M} - 0)(.5) = \100 M .¹³ If the project is terminating, then the incremental revenue in year 11 will be $-\$50 \text{ M}$, which will allow us to reduce our net working capital investment by $.4(50 \text{ M}) = 20\text{M}$ (cash in for the recovery of working capital). See *Termination cash flows* below.
8. Free Cash Flow from Operations = $\text{FCF}(\text{Ops}) = \text{NOPLAT} + \text{Depreciation} - \text{CAPEX} - \Delta\text{NWC} + \text{After-tax Salvage}$

What if the cash flow forecasts are real rather than nominal?

The future revenue and costs savings are forecast as annuities in the last example whereas, if product price and cost per unit are affected by inflation, we would expect these amounts to increase over time rather than be constant. Let's suppose that our forecasts of revenues and cost savings were, in fact, *real dollars* (in today's purchasing power) and assume that the annual inflation rate will be 5% per year in every future year. Let's assume that capital expenditure we have to make in five years was forecast in *nominal dollars*.

Reforecasting cash flows from the blast furnace investment making use of this information, we want to be consistent in our treatment of inflation: that is, we want to discount nominal cash flows at a nominal rate and/or discount real cash flows at a real rate. We could convert all nominal future cash flows to real cash flows, we could convert all real future cash flows to nominal cash flows or we could separate out the nominal

¹³The salvage proceeds after tax (as well as any asset sales) can be considered a negative capital expenditure. I separated this item out to show its effect on after tax cash flow more clearly.

and real components of each years' cash flow. Let's convert all real cash flows to nominal cash flows and calculate the annual Free Cash Flow from Operations on a nominal basis. This is done on Table 2. Things to notice on Table 2:

1. Revenues and Costs of Goods Sold have been "grossed up" by the amount of inflation between today and year t ; that is, they have been multiplied by $(1+\Pi)^t = (1.05)^t$, where Π is the expected rate of inflation per annum.
2. Depreciation is contractually fixed in advance. Having \$1,000 M in capital expenditures today means that you can depreciate \$100 M per year for ten years *in nominal terms*. So depreciation is nominal. We also assumed that the forecast \$200 M capital expenditure in year 5 is nominal, so the depreciation of in years 6 - 10 is also nominal.
3. Working capital requirements will now increase with the nominal sales level. Why? Think of the different asset/liability categories: if a certain percentage of sales are on account, then if sales increase (even due to inflation) the nominal level of working capital will increase. If required levels of unit inventories stay constant over time, but the cost of that inventory is increasing with inflation, then the dollar inventory level will increase with inflation. A similar argument applies to accounts payable. The change in working capital in each year is given by $\Delta(\text{Net Working Capital}) = .4(\text{Incremental sales})$.¹⁴
4. I assumed that the salvage values at year ten were originally forecast as nominal quantities.

¹⁴It should be pointed out that it is more common to estimate the working capital requirements as being concurrent with the change in sales, i.e., the \$21 M increase in NWC would be in year 1, then \$1 M increase in years 2-7, \$2 M increase in years 8 - 10 and the recovery of \$33 M in NWC in year 11. We have assumed NWC requirements occur a year in advance. See the next chapter for examples where the increase/decrease in working capital is assumed to be concurrent with the increase/decrease in sales.

Table 2. Blast furnace capital budgeting analysis, part I, Nominal cash flow analysis. (All amounts are in millions.)											
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Revenues		53	56	59	62	65	68	71	75	79	83
-Costs of Goods Sold		-95	-100	-105	-110	-116	-122	-128	-134	-141	-148
Gross Profit		148	156	164	172	181	190	199	209	220	231
-Depreciation		100	100	100	100	100	140	140	140	140	140
-Other Op Exp		0	0	0	0	0	0	0	0	0	0
Operating Profit before Tax		48	56	64	72	81	50	59	69	80	91
-Tax		24	28	32	36	41	25	30	35	40	46
Net Operating Profit after Tax		24	28	32	36	40	25	29	34	40	45
Add back Depreciation		100	100	100	100	100	140	140	140	140	140
Less CAPEX	1000					200					
Less Chg. Net Working Capital	21	1	1	1	1	1	1	2	2	2	-33
Salvage value after tax	-15										100
Free Cash Flow from Operations	-1,036	123	127	131	135	-61	164	167	172	178	318

The importance of termination cash flows: terminal value and continuing value

At the end of the blast furnace project, the firm could sell the blast furnace and parts to recover some of their investment. They will also be able to recover their investment in working capital (assuming that they haven't given credit terms to deadbeats, stored bad inventory, etc.). Ignoring these termination cash flows can lead to the rejection of otherwise sound investments. A more common error is to ignore the continuing value (often called residual value) of an investment (or strategy) if it is not expected to terminate at a specific future date N .

Most problems students are confronted with in classes in corporate finance are well-contained projects with well-defined starting dates and ending dates, usually having only one capital expenditure at the beginning of the project and generating known cash flows over the life of the project. While pedagogically sound, it gives the impression that most projects that companies actually consider have these features. For example, when the blast furnace considered in the last section wears out, will they not buy a new one? If they plan on closing the plant completely, then there are other cash flows to consider. If they will continue operating, then they will buy a new blast furnace at year ten. Alternatively, they could have repaired the old furnace and planned to replace it in two or three years. If the cash flows of these alternatives are known with certainty, we would have a "Project Interactions" type project, ala Chapter 6-3 of Brealey and Myers.¹⁵

Most large-scale investment decisions made by firms (e.g., Anheuser-Busch's decision to start selling "Ice Beer," General Motors's decision to start its Saturn division, Quaker's decision to spin off its Fischer-Price subsidiary, Marriott's decision to split the company up into its hotel operations businesses and its real

¹⁵If the cash flows of the project alternatives are uncertain, then there may be project options (or real asset options) which may be important in determining the value of the different alternatives: for example, if the future doesn't go as well as expected, they may decide to abandon early and take the salvage value early. If there are several investments available and some involve buying assets which are not as firm- or industry-specific, then this will make the *abandonment* option more valuable. If the project could be deferred, perhaps by making some repairs to the existing blast furnace, and by waiting for a more attractive investment may come along (perhaps a new site to build a state of the art facility), then this *deferral* option has some value. The valuation of investment or asset related options is related to option pricing theory and is discussed in Chapter 21 of Brealey and Myers.

estate business), don't have a natural ending date. Explicit forecasts of future cash flows, however, may be prepared for only so many years. You will often hear a variant of the following argument: "It is ridiculous to think that we can make accurate forecasts beyond five years so we don't forecast beyond that point." The flaw in this logic is that it assumes, when a number is difficult to forecast, the best estimate of the number is zero. This is not likely to be the case.

The solution to this problem is to estimate future cash flows explicitly for a certain number of years, N , as we did in the blast furnace example (where N was 10 years). Call this period the *forecast period*. At the end of the forecast period, make an assessment of the value of the project at that time, V_N . If V_N is the value of the project due to continuing operations, we call it the *continuing value* of the project; if, instead, it is the value from terminating the project, we call it the *terminal value* of the project. Discount the continuing/terminal value of the project back to the present along with the explicitly-forecast cash flows to the project to estimate the full project value. The longer the expected project life relative to the forecast period, the larger the error of omitting the continuing value of the investment. The more capital intensive the project is, the more likely the Free Cash Flow from Operations during the forecast period are likely to be small (perhaps even negative!). If you do not include cash flows beyond the "capital intensive" period, you will only be considering the "bad" aspects of the investment and not considering the "good" aspects of the investment. This may be a source of managerial myopia, i.e., a reason that managers don't pay sufficient attention to the long term value of investments. To illustrate the importance of continuing value in capital budgeting, we consider the following example.

Valuation of a division of a company: example

We consider the valuation of a consumer food products division of a large corporation. The parent corporation wants to value the division in order to assess different business strategies, including potential divestiture. Assume all forecasts are nominal, that the forecast period is ten years and that the division will

go on operating in perpetuity. The appropriate nominal cost of capital for this division is 10%.

The division has \$150 M book value of Property, Plant and Equipment (PPE) in place. Division sales last year were \$400 M and are forecast to grow at 8% per year during the forecast period. The products of the division are very profitable: the gross profit margin (exclusive of depreciation) is forecast to be stable at 12% of sales. To support the above sales growth, the company has to spend \$.10 in additional net working capital per dollar of incremental sales each year and must spend \$.50 in new capital expenditures (for maintenance of existing plant and equipment and for new plant and equipment) per dollar of incremental sales each year. Suppose that the firm takes 10% of the beginning of the year level of book value of PPE as their Depreciation Expense for tax purposes each year. The corporate tax rate is 40%. We can construct the annual Depreciation expenses as follows:

(1) Year	(2) Sales	(3) Beg. PPE	(4)=.1*(3) Depreciation	(5)=.5*Δ(2) New CAPEX	(6)=(3)-(4)+(5) End. PPE
1	\$432.0M	\$150.0M	\$15.0M	\$16.0M	\$151.0M
2	\$466.6M	\$151.0M	\$15.1M	\$17.3M	\$153.2M
3	\$503.9M	\$153.2M	\$15.3M	\$18.7M	\$156.5M
4	\$544.2M	\$156.5M	\$15.7M	\$20.2M	\$161.0M
5	\$587.7M	\$161.0M	\$16.1M	\$21.8M	\$166.7M
6	\$634.7M	\$166.7M	\$16.7M	\$23.5M	\$173.5M
7	\$685.5M	\$173.5M	\$17.4M	\$25.4M	\$181.6M
8	\$740.4M	\$181.6M	\$18.2M	\$27.4M	\$190.8M
9	\$799.6M	\$190.8M	\$19.1M	\$29.6M	\$201.4M
10	\$863.6M	\$201.4M	\$20.1M	\$32.8M	\$213.2M

The sales in each year is 8% higher than the last year; the new CAPEX each year is .5 times the incremental sales; the depreciation is .1 times beginning of the year book value of plant and equipment; the ending PPE is the beginning level of PPE less depreciation plus new capital expenditures. As you can see, the sales growth and the new investment requirements are integrally connected. Now that we have the depreciation expenses, we can generate our Free Cash Flow from Operations forecasts, which are given in Table 3 (on the next page). Things to notice on Table 3.

1. This is a Wordperfect table, not an imported spreadsheet. As such, some of the rounding is very funky.
2. The Revenues line represents 8% growth in sales each year.
3. Gross Profit is based on the gross profit margin of 12% of sales each year. Notice the other expenses line is zero. I have included other expenses (which could be, e.g., general, selling and administrative expenses) in my estimate of costs of goods sold for simplicity.
4. The Depreciation was calculated above.
5. Tax is calculated as 40% of Operating Profit before Tax.
6. CAPEX was calculated above and the Change in Working Capital is 10% of incremental sales each year.
7. The present value of the annual Free Cash Flow from Operations is calculated using the 10% cost of capital.
8. The total present value of Free Cash Flows from Operations is the sum of the present values of the annual Free Cash Flows from Operations.
9. The continuing value of the division at the end of year 10, V_{10} , is calculated by:

$$V_N = \text{Continuing Value} = \frac{NOPLAT_N}{r} \quad (2)$$

The continuing value is added to the Free Cash Flow from Operations in year 10 and discounted back to the present.

There are several methods to calculate the continuing value of the investment. They will be discussed in the next chapter. In the next section, I discuss the assumptions behind using equation (2) to calculate continuing value.

Continuing value as NOPLAT_N/r

We are assuming that the company will continue to operate in perpetuity. In each year, t , the company will generate Free Cash Flow $_t$ (FCF_t) given by the following relation:

$$\text{FCF}_t = \text{NOPLAT}_t + \text{DEPR}_t - \text{CAPEX}_{t(\text{maint.})} - \text{CAPEX}_{t(\text{growth})} - \Delta(\text{NWC})_t,$$

where CAPEX for maintenance and growth are separated into different terms. If we make the simplifying (and, I believe, reasonable) assumption that all firms reach a "date with destiny" after which it can be expected that **all new investments will earn an expected rate of return equal to the cost of capital** (i.e., all new investments after date N are zero NPV). If this is the case, then any $\text{CAPEX}(\text{growth})$ will be offset by the present value of the associated future positive cash flows they generate **exactly**. If all investments after year 10 are expected to be zero NPV, we can act **as if** those investments do not occur, because they do not increase or decrease value.

Next, the firm will have to make capital expenditures to maintain the plant and equipment of the firm, $\text{CAPEX}(\text{maint.})$; maintenance CAPEX of the firm will probably more than offset the annual DEPR of the firm (in an inflationary environment). Also, if sales are growing with inflation the required investment in working capital, ΔNWC , will be positive. We are making the extreme assumption, for simplification purposes only, that the nominal investment necessary to maintain the firm's assets and operations = **$\text{CAPEX}(\text{maint.}) - \text{DEPR} + \Delta\text{NWC}$** , exactly offsets any inflationary increase in NOPLAT, so the annual

FCF_t becomes:

$$FCF_t \text{ (after year } N) = NOPLAT_N$$

Since the resulting FCF is the same each year, we have a perpetuity of free cash flows, the present value of which is calculated in equation (2).

What is the value of the consumer food products division?

The total present value of the division calculated in Table 3 is \$329 M. If someone offers us \$330 M to buy the division from us, should we sell? This could be trickier than it looks. We were valuing the division as a stand alone business. We could ask the following questions:

1. Does the division have any interdivision sales? If they sell to other divisions, then the firm may be losing potential synergies associated with vertical integration of the businesses. Similarly, if they buy from other divisions of the company, then those divisions are potentially losing a client and potential vertical integration synergies also. More generally, are there synergies between the division we are valuing and the others? If there are, then \$329 may be too small a value. The reader should notice that synergies are incidental effects that should be included for capital budgeting purposes.
2. Does the division use corporate assets? For example, does the headquarters staff perform the payroll, accounting, pension plan and benefits functions for all the divisions? If so, have the incremental effects of these costs been included in the cash flow forecasts? If selling the division would allow the company to save money on these shared expenses, then perhaps the \$329 is too large.¹⁶
3. Lastly, will someone be willing to pay you *more than \$330 M*? Let's assume that there are no synergies between our division and the rest of the company and there are no shared expenses. Then \$329 M is the value of the division to the parent company. If you are seriously considering selling

¹⁶ Similarly, if a buyer would have to pay these costs, it will reduce the amount they are *willing to pay* for the division. We are only considering the value of the division to its parent company now.

the division, then you would still only sell for \$330 M if it were the highest offer you could obtain.

Why would another company be willing to pay more than \$329 M for these assets? These issues will come up in the mergers and acquisitions chapter, but we can mention a few:

1. The acquiring company may believe that they have larger synergies with the division than your synergies with the division.
2. The acquiring company may believe that the management of the division could be improved (hence, they could generate larger cash flows than those in your forecast).
3. The acquiring company could be overestimating either #1 or #2.
4. While we have not talked about financial synergies (we have assumed in this chapter that the project cash flows and the cost of capital are independent of the type of financing used), it may be that the acquiring company believes this division should be financed differently in a manner that would add value. The issue of the interaction between financing and investment decisions is addressed in Chapters 17-19 of Brealey and Myers.

Conclusions

In summary, we have covered the principles of cash flow analysis: i.e., that all the future cash flows of an investment are relevant, that they should always be measured on an *incremental, after tax basis* (using the with vs. without rule), and that we should be consistent in our treatment of inflation. The value of an asset (or investment) is the present value of its Operating Free Cash Flows discounted at the opportunity cost of capital. We defined Operating Free Cash Flow as after-tax profit from operations (ignoring financing cash flows), or NOPLAT, plus non-cash charges (Depreciation) less investments in fixed and working capital. This cash flow is the cash flow that is "left over" out of after-tax operating profit after all the planned investments in operations. This is money that can be (or must be, depending on the instance) used to pay

contributors of capital (i.e., bondholders and stockholders). Lastly, we discussed the importance of estimating terminal value or continuing value of an asset and used our methodology to estimate the value of a division of a company.