2

Value

2.1 Overview

To deliver sustainable shareholder value, management has to simultaneously manage operations in the short term while delivering on plans for the long term. Commitments in the short term include delivering on earnings and maintaining liquidity, while in the long term, they involve developing and executing on strategy and investments. The following framework discusses the metrics that encompass current and future performance.

The accounting foundations describe how the financial statements translate a business model and provide a framework for identifying value. The articulation of the financial statements identifies their stocks and flows, which provide the means to identify how a business generates value. Financial ratios provide a lens into the current performance of a firm to identify the factors that drive value. Return on shareholders' common equity (ROCE) and return on invested capital (ROIC) ratios are examined within this context.

Residual earnings (RE) account explicitly for the cost of equity in equity valuation, where returns greater than the cost of equity are required to create value. Free cash flow is a corporate finance concept that identifies a firm's cash flows that are available for distribution to various parties, which include equity and debt holders, while also continuing operations.

Intangible assets have increasingly become far more relevant with the rise of the information economy, along with their recognition and valuation on balance sheets. A pro forma analysis projects the financial statements of a firm, and has applications in valuation, strategy, credit analysis, M&A (mergers and acquisitions) and budgeting.

J. Rogers, *Strategy, Value and Risk*, Global Financial Markets,
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Corporate investment methods are then reviewed. Discounted cash flow (DCF) techniques and its shortcomings in the assumptions and decision rules are discussed. The advantages of real options techniques that address these issues are then outlined. The valuation of real options covers the issues associated with this technique, followed by the various types and definitions.

Corporate finance covers theory and builds a framework that extends on the initial model with the inclusion of growth options, an abandonment option, modularity and financial options. Finally, a firm's capital structure is discussed within this framework.

2.2 The Accounting Foundations

A business model provides a framework for identifying and creating value. Business models describe how the components of a business combine as a system. The phrase is widely used to describe the diverse features of a business, and its scope can include strategy, purpose, offerings, processes, operations, organizational aspects and trading practices. A good business model identifies the customer, what customers' value and how value is created in a business. The ability to identify how a business model functions and creates value provides a foundation for valuation.

Financial statements provide a framework for identifying how firm value is generated for shareholders and other stakeholders. The attributes of a business model are translated into accounting metrics that provide a lens into how and where value is created. Accounting principles define how financial statements are organized, and therefore, how value is measured. Firms generally issue three primary financial statements—the balance sheet, the income statement and the cash flow statement. One additional report usually required is the statement of shareholder's equity.

The balance sheet itemizes a firm's assets, liabilities and shareholder equity. Assets are a firm's investments that are anticipated to generate future payoffs. Liabilities are claims to payoffs on the firm by non-owner claimants, while shareholders' equity is a claim on the firm by its owners. The balance sheet is therefore a statement of the firm's investments and the payoff claims on those investments. Assets and liabilities are also identified as being either current or long-term, where current defines those assets that produce cash or how cash is used to pay liabilities within one year. The balance sheet's three components are linked through the following accounting relationship:

$$\text{Shareholders' Equity} = \text{Assets} - \text{Liabilities}$$

This accounting equation states that shareholders' equity is equivalent to a firm's net assets, or the net difference between the firm's assets and liabilities. Shareholders' equity is therefore the residual claim on a firm's assets after liabilities have been deducted.

The income statement provides an account of the increases or decreases in shareholder's equity that result from a firm's operations and activities. The value that is added to shareholder value is described by convention as the bottom line, net income, net profit or earnings. The income statement also itemizes the firm's revenues and expenses that are the foundation of net income. This is established though the following accounting relationship:

$$\text{Net Income} = \text{Revenues} - \text{Expenses}$$

The cash flow statement shows the cash generated and used by a firm over an accounting period. The various cash flows in the statement are identified as cash flows from operating activities, cash flows from investing activities and cash flows from financing activities. The total cash flows from the three definitions identify a firm's increase or decrease in cash activities:

$$\begin{aligned}\text{Change in cash} = {} & \text{Cash from Operations} + \text{Cash from Investment} \\ & + \text{Cash from financing}\end{aligned}$$

The statement of shareholders equity explains how a firm's equity has changed over an accounting period:

$$\begin{aligned}\text{Ending equity} = {} & \text{Beginning equity} + \text{Total}\left(\text{Comprehensive}\right) \\ & \text{Income} - \text{Shareholders' net payout}\end{aligned}$$

A firm's equity increases when value is added through operations as net income in the income statement, along with other comprehensive income and shareholders' investments, and decreases with payouts to shareholders.

2.2.1 Stocks and Flows

The articulation of the financial statements describes their relationships or the manner in which they fit together. The balance sheet provides the stock of

owner's equity and cash at a point in time, while the cash flow statement accounts for how the stock of cash has changed over time. The statement of shareholder equity, which identifies the change in owner's equity or flows over two balance sheet dates, describes the relationship between the income statement and balance sheet. The income statement, adjusted for other comprehensive income in the equity statement, describes the change in owners' equity derived from the value added from operations.

Identifying the articulation of the financial statements reveals their stocks and flows, which provide a foundation for the analysis of how a business generates value. The balance sheet describes the stock of value in a firm at a point in time, while the income statement and cash flow statement account for the flows, or change in stocks, between two points in time in the balance sheet. The statement of shareholders equity equation given earlier is the stocks and flows equation for equity, as it describes how the stocks of equity have changed with the equity flows. The cash flow relations described in the cash flow statement equation is the stocks and flows equation for cash.

The stocks and flows concept can be extended to define value, with the balance sheet providing the shareholders' net worth as a stock, while flows are the value added through a firm's operations in the income statement, and in the cash flow statement as changes in cash. Therefore, the value that flows to a firm's owners is the change in equity over an accounting year.

The value of a firm should always equal the value of the claims on the firm:

$$\text{Firm value} = \text{Value of debt} + \text{Value of equity}$$

This relationship illustrates that total firm value is distributed to the various claimants on that value. Firm valuation can therefore be defined as either valuing the firm itself, or valuing and summing the claims on the firm. The firm also has a portfolio of projects, with the value of the firm represented by the present value of the expected cash flows from operations, or free cash flows, from these projects. Firms seek continuity by investing in new projects while letting existing projects terminate. The cash generated from a firm's assets and operations flows to the claimants on the firm. Therefore, the analysis of a firm's operations, financing activities and investments provides the foundation on how firm value is generated and the sustainability of that value creation.

Figure 2.1 illustrates all the stocks and flows of a firm. The firm's debt and equity financing activities are transacted with claimants in the capital markets. At inception, a firm begins with funding sourced as cash from shareholders. This cash is initially invested in liquid financial assets such as short-term

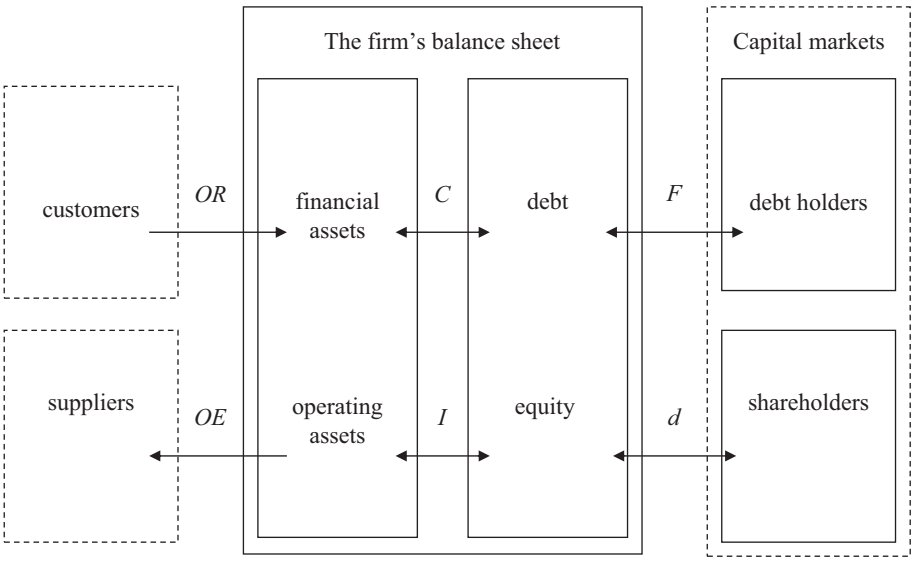

Fig. 2.1 The stocks and flows of a firm

money market securities before being invested in operating assets. Additional funds are also raised as debt to fund balance sheet assets. Cash that moves between the debt holders and the firm is defined as the net debt financing flow, *F*. This net cash flow consists of cash paid as interest and principal repayments to debt holders minus cash borrowed by the firm from its creditors. Similarly, the net dividend to shareholders *d* represents cash paid as dividends and stock repurchases minus capital cash injections from shareholders.

Firms divest the cash in financial assets to invest in operating assets, described by the firm's investing activities, *I*. These cash flows can move in either direction, with investments in financial assets also flowing from the proceeds of liquidating operational assets such as discontinued operations. Net cash flows are then generated from the operating assets, defined as cash from operations, *C*, through the operating income generated by operating revenues, *OR*, minus the operating expenses, *OE*. This cash from operations is then invested in liquid financial assets, and so, the cycle continues.

An important identity is the cash conservation equation, or sources and uses of cash equation. The four cash flows—cash flow from operations, *C*; cash investment, *I*; net cash flow to debt holders and issuers, *F*; and net cash flow to shareholders, *d*—always observe the relationship:

$$C - I = F + d$$

Or, free cash flow equals the net payments to debt holders and debt issuers plus the net dividends to shareholders. Cash flow from operations minus the cash investment in operations, therefore, is always equivalent to the net cash flows to debt holders and shareholders.

The left hand side of the relationship, $C - I$ represents a firm's free cash flow. Free cash flow is positive if operations produce more cash than required for new investment, and negative if operations create less cash than required for new investment. A positive free cash flow is either invested in financial assets, F, or distributed as dividends, d. A negative free cash flow necessitates either the issuing of bonds, a negative F, or the issuing of stock, a negative d, to meet the cash shortfall.

The following identities also hold for corporate cash management. If

$$C - I - i > d,$$

where i is the net interest cash flow, or the interest paid minus the interest received, then either lend or buy down the firm's debt. If,

$$C - I - i < d,$$

then either borrow or reduce lending.

2.2.2 Ratio Analysis

A multiple is the ratio of the market price of a firm's stock to some accounting measure per share that is used as an estimate of relative value. A price multiple summarizes the relationship between a firm's stock price and a measure such as earnings, book value or sales per share.

The price-earnings (P/E) ratio compares the current stock price with earnings, and anchors a valuation to an income statement. The ratio is interpreted as:

- the price or numerator reflecting future earnings, or the market's expectations of value added from future sales, and
- earnings, the denominator, reflecting current earnings, or the value added from current sales

The P/E ratio therefore evaluates the forecast of future earnings in relation to current earnings. Higher future earnings expectations relative to current earnings should result in a higher P/E ratio, while lower future earnings expec-

tations relative to current earnings should result in a lower P/E. The P/E ratio is, therefore, an indication of anticipated earnings growth.

The price-to-book ratio, or P/B ratio, compares a firm's book value to its current market price. The P/B is derived as:

- the ratio of the firm's market capitalization over the firm's total book value, or
- a per-share value, the ratio of the firm's current share price over its book value per share, or the ratio of book value over the number of shares issued

By convention, book value does not include intangible assets.

A firm's book value represents the shareholders' investment in the firm, with the value derived on the expectations of how much the net assets will earn in the future. Book value can either increase or decrease, depending on the firm's future earnings expectations. While book value does not accurately determine value, the missing component is ultimately realized in the future earnings created by book value.

The stock price in the P/B ratio's numerator is based on expected future earnings. Therefore, the higher expected earnings are in relation to book value, the higher the P/B ratio. The book value rate of return, or profitability, is a measure that principally determines P/B ratios. The market price-to-book value ratio is the price-to-book ratio or the market-to-book ratio, while the intrinsic value-to-book value ratio is the intrinsic price-to-book ratio.

Return on shareholders' equity (ROE), or more specifically, return on shareholders common equity (ROCE) measures the rate of return on common stock:

$$\text{ROCE} = \frac{\text{Comprehensive income}}{\text{Average CSE}}$$

The measure assesses a firm's profitability efficiency per unit of shareholders' equity or book value. ROCE can be decomposed into three drivers:

$$\text{Net profit margin} \times \text{Asset turnover} \times \text{Financial leverage.}$$

or,

$$\text{Net income / Sales} \times \text{Sales / Total assets} \times \text{Total assets / Average shareholder equity}$$

Net profit margin is a relative measure of the rate at which profitability is generated from operating assets, or the dollar of net profit generated from a dollar of sales revenue. Asset turnover measures the efficiency of operating assets, and describes the relationship between the use of assets and profitability. The ratio focuses on the volume of sales generated from an investment in operating assets, or the dollar of sales revenue generated for each dollar invested in operating assets. Asset turnover centres on two operating asset groups—the working capital assets, such as cash, inventory and receivables; and the fixed assets that include plant, property and equipment. The leverage ratio describes the degree to which a firm relies on debt to create profitability. A firm can increase its asset base through financial leverage or borrowing, which can enhance the returns to shareholders.

The first two ROCE drivers—net profit margin x asset turnover—define the return on assets (ROA) ratio. ROA establishes a firm's efficiency in the use of assets and is also a profitability measure. The Du Pont Formula integrates the analysis of a firm's profitability and investments in assets, and provides a window into the sources of a firm's profitability. High net margins indicate that customers are prepared to pay more for a firm's products, while a high asset turnover indicates that a firm uses its assets relatively more efficiently in generating sales, and therefore, invests less capital. The return to shareholders can therefore be increased by either increasing the profit per dollar of sales, or increasing the sales dollars generated from the operating assets.

Return on invested capital (ROIC) measures a firm's success in generating cash flow relative to its invested capital. The measure is derived as net operating profit after taxes (NOPAT) divided by invested capital, which includes working capital, debt, and common and preferred stock:

$$\text{ROIC} = \frac{\text{NOPAT}}{\text{Invested capital}}$$

Firm value is created when the ROIC is greater than the cost of capital, and value lost if the spread is negative. ROIC provides a better metric for the analysis of a firm's performance than ROCE and ROA as it centres on a firm's actual operations. ROCE combines operations with leverage, while ROA understates a firm's profitability as it does not include the leverage from operating liabilities or the profitability from financial assets. ROIC driver patterns reveal a fade rate or persistence where the ROIC reverts to a long run level. Economic factors typically influence firms in a comparable manner within industry sectors, and drivers tend to fade to levels that are representative for an industry.

2.2.3 Residual Earnings and Free Cash Flows

Residual earnings is net income minus a deduction that represents the common shareholder's opportunity cost in generating net income. For each earnings period, residual earnings (RE) is derived as:

$$\text{RE} = \left(\text{ROCE} - \text{Required return on equity}\right) \times \text{Book value of common equity}$$

where ROCE equals $\text{earnings}_t/B_{t-1}$ and is the rate of return on common equity. Two value drivers therefore determine residual earnings, the ROCE and the book value B_{t-1} for each period.

Firm value is generated over book value by increasing the ROCE spread over its cost of capital. Value is additionally increased by the growth in book value, or net assets, which earn at the firm's ROCE. A value strategy can therefore be framed as increasing firm value through investments and strategies that increase ROCE over the required return, and grow book value or net assets.

A firm and its equity can also be valued by discounting the free cash flow to the firm and the free cash flow to equity. Free cash flow to the firm (FCFF) measures the net cash generated by a firm, while the free cash flow to equity (FCFE) measures the cash distributed to the firm's equity shareholders after all reinvestments, debt repayments and expenses. Both measures can be derived from the financial statements, from either the net income statement or the statement of cash flows.

In the case of the income statement:

$$\text{FCFF} = \text{NI} + \text{NCC} + \text{IE}\left(1 - \text{Tax rate}\right) - \text{IWC} - \text{IFA}$$

where:

NI = net income, or profit after tax
NCC = net non-cash charges
IE = interest expense
IWC = investments in working capital
IFA = investments in fixed assets

In the case of the statement of cash flows:

$$\text{FCFF} = C + \text{IE}\left(1 - \text{Tax rate}\right) - \text{IFA}$$

where:

C = cash flow from operations
IE = interest expense
IFA = investments in fixed assets

Free cash flow to equity is derived from free cash flow to the firm as:

$$\text{FCFE} = \text{FCFF} - \text{IE}\left(1 - \text{Tax rate}\right) + \text{NB}$$

where:

IE = interest expense
NB = net borrowing, or change in debt

Free cash flows also vary over the life cycles of products and firms. Product and firm life cycles are related in that the product life cycle is the demand side counterpart to the industry life cycle. Firms and products progress through the stages of emerging, growth, mature and decline, or in some cases, can stay at a mature stage indefinitely. Some product cycles have a long lifespan, such as steel, paper and cement manufacturing, while products such as electronics and pharmaceuticals can have relatively short lifespans.

2.2.4 Intangible Assets and Intellectual Property

The value of a firm as a going concern lies in its income stream, with its assets the resource that generates value. The rise of the information economy has increased attention on the recognition and valuation of intangible assets on corporate balance sheets. Balance sheets explicitly exclude assets such as brands, distribution and supply chains, and knowledge, organization and human capital. This issue is especially relevant when firm value is derived more from intangible assets rather than tangible assets. The majority of intangible assets on balance sheets, however, cannot be identified and independently valued from other assets, as their value is derived from the cash flow streams generated with other assets. Knowledge capital is used in processes, marketing and management, and does not exist without tangible assets, while

value from organizational capital is derived from its combination with other assets. As such, the firm itself is the asset, or an organization of assets that underlies a business plan to create value.

Asset values can however be determined from the income statement in addition to a balance sheet. The articulation of the income statement and balance sheet can reveal firm value, with each statement correcting for the shortcomings of the other. In the case of intangible assets, an income statement or flow valuation is available when a balance sheet or stock valuation cannot be determined. Although intangible assets are absent from the balance sheet, the earnings from intangible assets still flow through the income statement. As such, value can be determined by either measuring the asset value directly, or through the capitalization of the earnings from that asset itself. Although a balance sheet does not provide a summary amount for the value of assets used in combination, the income statement in principle does so. Earnings measure the value added from tangible assets in conjunction with entrepreneurship, knowledge, organizational capital and brands. Identifying the intangible assets on a balance sheet therefore is not required, as the earnings generated by the business plan provide a summary measure of value.

Intangible assets, when compared to tangible assets, generally not only have no physical identity, they also cannot be identified for the purpose of writing contacts against them for delivery. Legal rights such as patents and copyrights, and in some cases, brands are exceptions, however. As firms move to more open models of innovation and external sources of knowledge, the management of intellectual property rights (IPR) has become a significant issue. Examples of IPRs that can be licensed include patents, copyrights and trademarks; however, patent licenses are the most frequent in technology exchanges. This increasing reliance on external sources of innovation means that it is essential to have consistent measurements of what is being traded.

2.2.5 Pro Forma Analysis

Pro forma financial statements are projected forecasts that have a variety of applications, which include:

- strategic planning, such as merger and acquisition transactions and new capital investments
- financial planning, including revenue and expenditure planning; working capital modelling, capital structure analysis and short- and long-term borrowings

- credit analysis for debt covenants such as debt-to-equity ratios and debt service reserve coverage, and
- the design and valuation of securities

Pro forma financial statements provide an integrated projection of a firm's future operating prospects and financial condition, based on the current financial statements. A pro forma income statement provides an earnings estimate, and a pro forma balance sheet, the book value of equity as bottom line numbers. Forecasted free cash flows are derived from the pro forma cash flow statement, where net income and depreciation are used to construct the statement, which then provides data for the projected pro forma balance sheet. The pro forma cash flow statement is then available for forecasting free cash flows for use in financial planning, DCF analysis and liquidity analysis. Finally, the pro forma statements are modelled for multi-year projections, the data translated into values, and the projected firm value divided among the shareholders, debt holders and any hybrid security holders.

The consequences of changes in business conditions and the available choices in managing these changes can also be analysed in a pro forma. Scenarios that represent transformations in industries and the external environment can be integrated into an analysis of future performance. Building a pro forma therefore requires identifying factors that are a function of business conditions and those that are management choices. These factors include changes in products, markets, technologies, industries and regulations, while management decisions include identifying those key drivers to which the firm has an exposure, which can add value and which ensure firm continuity.

Sensitivity analysis is the modelling of the set of possible future balance sheets and income statements and identifying what is at risk. Value is framed based on whether a firm can grow book value and where it will be positioned in future years. Risk can be analysed by using different scenarios in the pro forma statements, including the best and worst scenarios, and the base case to find the margin of safety. Macro and micro economic effects and event risks can also be included in the scenarios. As financial reporting moves stock prices through earnings releases, the set of alternative accounting outcomes that will influence a firm's stock price can also be modelled.

A pro forma analysis can include an industry's driver patterns, industry and economic forecasts, how a firm's key drivers will diverge from conventional patterns, management's options versus the external environment, and the firm's projected book value. A percentage-of-sales pro forma framework example is used as an illustration, with quarterly intervals up to 12 months, followed by yearly intervals up to three years.

The following assumptions were made:

- the rate of sales growth is constant at 5%
- cost of sales are 80% of sales
- the current assets are 30% of sales
- the fixed assets are also a ratio of sales at 100%
- the parameters are assumed to be constant over the three-year forecast
- a total of 1000 shares are issued

Table 2.1 summarizes the data for the pro forma analysis example:

Table 2.2 shows the pro forma income statement and balance sheet. The pro forma statements illustrate the articulation of the accounting statements. Retained earnings, the last line of the income statement, represents the change in the retained earnings line item in the balance sheet, while changes in the income statement and balance sheet form the foundation for the statement of cash flows.

Table 2.3 shows the pro forma free cash flows. The calculations start with profit after taxes, and reverse the accruals to arrive at free cash flow.

The GAAP Statement of Cash Flows mingles free cash flows with the flows from financing activities, where cash flow from operations minus the cash used for investing activities plus the cash from financing activities equals the change in cash and cash equivalents. Realigning the statement of cash flows draws a distinction that follows the four cash flows that were linked together in the cash conservation equation $C - I = F + d$ in Sect. 2.2.1 (Stocks and Flows), as illustrated in Table 2.4.

Table 2.5 shows the calculation of the valuation of equity from the free cash flows to equity, which is derived by discounting the equity cash flows for each year up to three years, with a terminal value added to the equity cash flow at Year Three.

The terminal value at Year Three is derived as a perpetuity, with the Year Three equity free cash flow projected through multiplying by 1 plus the FCFE growth rate, and dividing by the equity discount rate minus the growth rate.

Table 2.1 The pro forma example data

Operations		Assets		Financing	
Initial sales	1000	Current assets (% sales)	30%	Interest expense	3%
Sales growth (annual)	5%	Current liabilities (% sales)	10%	Dividend payout ratio	65%
Cost of sales	80%	Fixed assets (net, % sales)	100%	Cost of equity	8%
Taxes	40%	Depreciation	10%	Debt/equity ratio	60%

Table 2.2 The pro forma income statement and balance sheet

Income statement	Y0	Q1	Q2	Q3	Q4	Y1	Y2	Y3
Sales	1000.0	262.3	262.4	262.6	262.7	1050.0	1102.5	1157.6
Cost of sales		(209.8)	(209.9)	(210.1)	(210.2)	(840.0)	(882.0)	(926.1)
Interest		(3.0)	(3.0)	(3.1)	(3.1)	(12.2)	(12.8)	(13.5)
Depreciation		(1.4)	(1.4)	(1.4)	(1.4)	(5.6)	(5.8)	(6.1)
Profit before taxes		48.1	48.1	48.0	48.0	192.2	201.9	211.9
Taxes		(19.2)	(19.2)	(19.2)	(19.2)	(76.9)	(80.7)	(84.8)
Net income		28.9	28.8	28.8	28.8	115.3	121.1	127.2
Dividend		(19.0)	(19.0)	(19.0)	(19.0)	(76.1)	(79.9)	(83.9)
Retained earnings		9.8	9.8	9.8	9.8	39.2	41.2	43.2

Balance sheet	Y0	Q1	Q2	Q3	Q4	Y1	Y2	Y3
Assets								
Current assets	300.0	303.7	307.4	311.2	315.0	315.0	330.8	347.3
Fixed assets	1111.1	1124.7	1138.6	1152.5	1166.7	1166.7	1225.0	1286.3
Depreciation	(111.1)	(112.5)	(113.9)	(115.3)	(116.7)	(116.7)	(122.5)	(128.6)
Net fixed assets	1000.0	1012.3	1024.7	1037.3	1050.0	1050.0	1102.5	1157.6
Total assets	1300.0	1316.0	1332.1	1348.5	1365.0	1365.0	1433.3	1504.9
Liabilities								
Current liabilities	100.0	101.2	102.5	103.7	105.0	105.0	110.3	115.8
Debt	387.5	392.3	397.1	401.9	406.9	406.9	427.2	448.6
Equity								
Stock	802.5	802.7	803.0	803.4	803.9	803.9	805.4	806.9
Retained earnings	10.0	19.8	29.6	39.4	49.2	49.2	90.4	133.6
Total liabilities	1300.0	1316.0	1332.1	1348.5	1365.0	1365.0	1433.3	1504.9

Table 2.3 The pro forma free cash flow forecast

	Y0	Q1	Q2	Q3	Q4	Y1	Y2	Y3
Profit after taxes		28.9	28.8	28.8	28.8	115.3	121.1	127.2
+ net non-cash charges (depreciation)		1.4	1.4	1.4	1.4	5.6	5.8	6.1
+ interest expense after taxes		1.8	1.8	1.8	1.9	7.3	7.7	8.1
– change in net working capital		(2.5)	(2.5)	(2.5)	(2.5)	(10.0)	(10.5)	(11.0)
– change in fixed assets		(13.6)	(13.8)	(14.0)	(14.1)	(55.6)	(58.3)	(61.3)
Free cash flow		15.9	15.8	15.6	15.4	62.7	65.8	69.1

The growth rate is derived as $g = (1 - \text{payout ratio}) * \text{ROCE}$, and is assumed to be constant for illustration. The present value of the equity cash flows is derived as $\text{FCFEt}/(r_{equity} - g)$, where r_{equity} is the cost of equity, which is divided by the number of shares to arrive at the value per share.

Table 2.6 shows the ROCE, ROIC and projected book value as the sum of the balance sheet stock and retained earnings line items.

Table 2.4 Free cash flows and financing flows

		Q1	Q2	Q3	Q4	Y1	Y2	Y3
Cash flow from operations	*C*	32.0	32.0	32.1	32.1	128.2	134.6	141.4
Investments	*I*	(16.1)	16.3)	(16.5)	(16.7)	(65.6)	(68.8)	(72.3)
Free cash flow	*C* – *I*	15.9	15.8	15.6	15.4	62.7	65.8	69.1
Debt financing flows:								
Change in financial assets (net)		–	–	–	–	–	–	–
Financial asset interest		–	–	–	–	–	–	–
Debt issuance (net)		(4.8)	(4.8)	(4.9)	(4.9)	(19.4)	(20.3)	(21.4)
Debt interest expense		1.8	1.8	1.8	1.9	7.3	7.7	8.1
	F	(2.96)	(2.99)	(3.03)	(3.07)	(12.05)	(12.65)	(13.29)
Equity financing flows:								
Dividends and stock repurchases		19.0	19.0	19.0	19.0	76.1	79.9	83.9
Stock issuance		(0.2)	(0.3)	(0.4)	(0.5)	(1.4)	(1.5)	(1.6)
	d	18.9	18.7	18.6	18.5	74.7	78.5	82.4
Total financing flows	*F* + *d*	15.9	15.8	15.6	15.4	62.7	65.8	69.1

Table 2.5 Valuation of equity from free cash flow to equity

	Y0	Y1	Y2	Y3
Free cash flow		62.7	65.8	69.1
– interest expense after taxes		(7.3)	(7.7)	(8.1)
+ change in debt		19.4	20.3	21.4
Free cash flow to equity		74.7	78.5	82.4
Terminal value				2198.2
Total cash flows		74.7	78.5	2280.6
PV total cash flows		73.5	74.7	2103.2
Cost of equity	8.0%			
Growth rate	4.7%			
Value of equity	2251.5			
Value per share	2.25			

Table 2.6 ROCE, ROIC and projected book value

	Y0	Q1	Q2	Q3	Q4	Y1	Y2	Y3
ROCE		3.5%	3.5%	3.4%	3.4%	13.8%	13.8%	13.8%
ROIC		2.2%	2.2%	2.2%	2.1%	8.7%	8.7%	8.7%
Book value	812.5	822.5	832.6	842.8	853.1	853.1	895.8	940.6

2.3 Corporate Investments

2.3.1 Investment Methods

Investment can be defined as the sacrifice of current dollars for future dollars (Sharpe, Alexander & Bailey). Understanding how investments are valued is

important for investors, finance executives or management generally. Assets are only worth what someone is willing to pay for them, and as that person could be an analyst, a trader, a fund manager or a competitor, a background in the available valuation methods is essential. Investment valuation is used for a wide range of real and financial assets, including companies, bonds, stocks, real estate and derivatives. Although most investment valuation models are generalized rather than specific to particular markets, it is also probably one of the most difficult tasks in finance.

Many factors can have an impact on the value of investments. Errors in forecasts can result from unforeseen changes in factors such as financial variables, markets, competitors and technology. Unexpected changes in asset values can also result from factors that are completely unrelated to a firm, an industry or the economy generally. Another major influence today on the value of investments is the corporate emphasis on short-term results. A firm will either be rewarded or penalized every quarter through its share price, depending on whether earnings satisfy investor expectations. A consequence often seen is the corporate behaviour of managing quarterly financial results to reduce share price volatility.

The basis for an investment will depend on the investment philosophy. Generally, the value of an asset should be a function of the cash flows it is expected to produce. A wide variety of models are used for investment valuation with various levels of complexity; however, there are some common features. Two common approaches are DCF valuation and relative valuation, which is similar to DCF in the sense that the value of an asset is derived from the cash flows of comparable assets. DCF analysis can be performed either from the viewpoint of equity holders, in which case, the expected cash flows to equity are discounted, or by considering the firm from all perspectives and discounting the firm's expected cash flows.

2.3.2 DCF Valuation

There are two basic approaches to discounted cash flow methods—the net present value (NPV) and the internal rate of return (IRR). The NPV is the difference between the present value of the net cash inflows generated by the asset and the initial cash outlay. The IRR is the rate of return that equates the present value of the net cash inflows generated by the asset with its initial cash outlay. The IRR is the equivalent to interest rates quoted in financial markets. The NPV approach is the most popular, and has the following features:

- NPV recognizes the time value of money.
- NPV is a function of the future cash flows from an investment and reflects the opportunity cost of capital.
- Net present values can be aggregated as they are measured in today's values.

The NPV of an investment is the sum of the present values of the expected benefits, generally in the form of cash flows, from which the present values of all expected cash outlays are deducted. The variable k is defined as the rate of return that can be earned on an alternative investment. If I_0 is defined as the initial outlay, and CF_t the cash flow at the end of period t, the net present value is:

$$NPV = \frac{CF_1}{(1+k)^1} + \frac{CF_2}{(1+k)^2} + \ldots\ldots\ldots\ldots + \frac{CF_n}{(1+k)^n} - I_0 \qquad (2.1)$$

2.3.3 The Net Present Value Rule

The net present rule is to accept investments that have positive net present values, that is, when the present value of the investment's cash inflows are at least as large as the present value of the cost outlays. There are some implicit assumptions underlying the NPV method (Dixit and Pindyck 1994):

- the investment can be reversed or unwound and any outlays recovered if circumstances prove to be less than expected, or,
- the choice is either a now or never decision, even if the investment cannot be reversed—if the investment is not made immediately, then it cannot be made in the future

Most investments actually do not meet these requirements. Instead, the majority of investment decisions have three central features that interact at various levels:

- The investment cannot be reversed, if not totally, then as least to some degree, in which case, the initial investment is, to some extent, a sunk cost, or a cost that cannot be recovered.
- The investment's future payoffs have an associated uncertainty.
- There is some flexibility in the investment timing. There is an opportunity to delay a decision until further information becomes available.

The opportunity to delay and the inability to reverse an investment decision are significant features found in most investments. NPV valuations, however, compare investing immediately with never investing, and reflect a static value derived from assumptions that only consider a single scenario. An NPV analysis does not recognize any flexibility management has to assess and react to future circumstances that were not initially anticipated. The NPV approach assumes a static commitment to a static strategy. Any business case based on NPV analysis will therefore ignore management's potential to modify a decision alternative in the future.

Although the NPV approach assumes a predetermined path no matter how events materialize, the business environment today is anything but static. NPV techniques are not designed to capitalize on future opportunities when they arise, or to manage any potential downside risks. NPV valuation methods do not include the value of the opportunity to wait and act in the future as more information becomes available. NPV valuations also imply that risk is a single dimension that reduces value. All uncertainties and decisions are reduced to one single scenario that is adjusted for risk through the level of a discount rate.

2.3.4 Real Options

Real options analysis is a valuation and strategic decision paradigm that applies financial option theory to real assets. Stewart Myers (Myers 1987) first referred to the term in a discussion about the gap between strategic planning and finance theory. DCF analysis, developed from finance theory, made sense when applied to businesses such as 'Cash Cows'. However, the dynamics associated with today's business environment are putting limitations on the DCF techniques used to analyse them. Risk can also be leveraged to create, rather than suppress value. Hedges can protect investments from downside risks while an exposure is maintained to any upside potential. Real options offer a framework and the metrics for managing strategy, value and risk in today's business environment.

Firms will typically invest in projects that generate a return greater than a hurdle rate. Hurdle rates can, however, be often observed at three to four times the cost of capital (Dixit and Pindyck 1994). One explanation is the implied option value, or opportunity cost associated with a capital investment. Instead of the investment decision being that discounted cash inflows must equal or exceed discounted cash outflows as per the NPV rule, the investment's cash inflows must exceed the cash outflows by the value of keep-

ing open any optionality in the investment. If a decision is made to proceed with an irreversible investment, the opportunity to delay the investment is forfeited, and so, the rights to any option implied in the investment are exercised. This opportunity cost should therefore be included in the valuation of an investment.

The NPV rule should therefore be revised by subtracting the opportunity cost of exercising any options, and then, investing if the modified NPV is positive. The alternative is to keep the conventional NPV and the option value distinct. The investment framework can therefore include two identified value components—the NPV and the real option value. A strategic NPV can be defined as (Trigeorgis 1996):

$$\text{Strategic NPV} = \text{Standard NPV} + \text{Option Premium}$$

The modified NPV rule is now to invest if the Strategic NPV is greater than zero.

2.3.5 Valuing Real Options

Financial options are asymmetric relationships, where the option holder has a right but not the obligation to transact at a contracted price (the exercise price) on or before a predetermined date (the exercise or maturity date). A call option is the right to buy, and a put option is the right to sell the underlying instrument at the exercise price. A European Option can only be exercised at the end of its life, while American Options can be exercised at any time during its life. In the case of a real option, it is the right but not the obligation to act, such as deferring, expanding, contracting or abandoning a project or investment at a predetermined cost (the exercise price) for a predetermined period of time (Trigeorgis 1996 and Copeland and Antikarov 2001). Value is created in a financial option from the volatility in an underlying financial asset, and the same concept is applied to real options, where value is derived from the uncertainty or the volatility associated with a real asset.

A relatively simple argument has been developed in financial economics to price an option under the assumption that no arbitrage opportunities exist. An economy exists that has an abundant set of traded assets from which a portfolio can be created. This portfolio consists of buying a specific number of shares of a stock, against which a certain amount is borrowed at a risk-free rate such that the portfolio replicates an option's returns in any state of nature. In the absence of any arbitrage opportunities, or risk-free profits, the option

and the corresponding portfolio must sell for the same price as they provide the same future return. Therefore, the price of the option is the equivalent to the cost of setting up the replicating portfolio.

The no-arbitrage replicating portfolio concept used to price options can be applied to real options by employing the assumptions used in deriving the NPV of an asset or project. The discount rate used in DCF analysis typically estimated using the Capital Asset Pricing Model (CAPM) is based on the price of traded twin security with the same risk characteristics as the investment or project being analysed. Therefore, the same traded twin security can be used to replicate the real option's returns. This leads to an important assumption in valuing real options—that existing assets in the economy span the risks in the asset or project being valued. Capital markets must be adequately complete so that an asset exists such that its price is perfectly correlated with the asset underlying the real option. Real options can, however, have risks that are not priced or spanned in the financial markets. These risks that cannot be represented by the price of a traded security are known as private risks.

Incomplete markets can be found in all real asset markets, and even in financial markets. Incomplete markets are likely to remain in regards to a specific risk if the costs exceed the benefits of creating the securities required to span a specific risk, or if there are problems associated with making such securities legitimate. Other market imperfections include intermittent trading, sporadic price discovery and a lack of liquidity. Robert Merton (1998) presented a framework in his 1997 Nobel Prize lecture for determining the value and risk of a non-traded asset by using a portfolio of traded securities. There are two aspects that can be drawn from Merton's address. The first is that it is probable that some kind of tracking of the risks in a corporate investment can be established through a portfolio of traded securities, in spite of market imperfections. The second is the rigorous definition Merton offers of private risk. Merton defines and measures private risk as the size of the tracking error between the portfolio of traded securities and the value of the underlying asset. Private risk can therefore be identified through the data, rather than through subjective breakdowns of market and private risks.

Other techniques that can be used when spanning does not hold are decision analysis and dynamic programming. Decision analysis is a structured quantitative approach for the evaluation of decisions that have complex alternatives, competing objectives and major sources of uncertainty. The origins of decision analysis began at Harvard Business School in the early 1960s as a continuation of the quantitative advances in operations research and management science. Decision analysis combines systems analysis, which

considers the interactions and dynamic behaviour of complex situations, and statistical decision theory, which focuses on logic in simple uncertain situations. Merging these two concepts into decision analysis provided a focus on logic in complex dynamic and uncertain situations.

Real options and decision analysis both have the common goal of modelling the decisions and uncertainties associated with investments. Where there is a distinction between the real options and decision analysis method is in the definition of valuing risky cash flows. Valuation in decision analysis is derived from the values and preferences of an individual or organization, whereas valuation in real options is derived from prices in traded markets. As value in real options is based on markets, risk-neutral probabilities and risk-free discount rates, the utility functions and risk adjustments to discount rates as used in decision analysis are unnecessary.

Dynamic programming was developed as an approach to the optimal control problem found in an area of economics called dynamic optimization. Optimal decisions problems, where current decisions influence future payoffs, can be solved using dynamic programming, and it is particularly useful when dealing with uncertainty. The method derives possible values of the underlying asset by extrapolating out over the duration of the option, and then, folding back the value of the optimal future value to the present. Dynamic programming can deal with complex decision structures that include constraints and complex relationships between the option value and the underlying asset. The binomial option pricing method is a form of dynamic programming.

Dynamic programming and contingent claims analysis are based on similar partial differential equations. There are also similarities in the way the Bellman equation used in dynamic programming is interpreted in terms of an asset value and to what degree investors are prepared to retain that asset. In contingent claims analysis, boundary conditions define where investors decide on the optimal exercise date that maximizes asset value. The main difference lies in the definition of the rate of return. Dynamic programming specifies the discount rate exogenously, and is therefore considered a subjective valuation of risk. In contingent claims analysis, the rate of return on an asset is derived from assets traded in financial markets.

The holder of a financial option has an exclusive right over exercising that option. The same, however, is not always the case in real options. Some real options will be exclusive or proprietary, and therefore, the holder of the real option will have sole exercise rights without the threat of competitors. Other investment opportunities however will have shared real options and may also be available to competitors or other potential participants. Other possible

situations are where shared real options have no value as they collectively belong to a whole industry, or where they are a public good.

In option markets, the best strategy for the holder of a non-dividend paying American call option on a stock is typically to delay the exercise until the option maturity. There is no opportunity cost associated with waiting to exercise the option, and therefore, the holder of the call option would rationally wait as long as possible before exercising that option. If a stock does pay a dividend, however, its value will typically fall after the dividend payout, and so, reduce the payoff for a dividend-paying American call option if it is exercised immediately after the dividend payout.

There is, therefore, an associated opportunity cost in waiting to exercise if a stock option does pays a dividend, in which case, early exercise would be a better strategy. In a similar sense, if there were no opportunity costs associated with delaying an investment, the holder of a real option would wait until its maturity before exercising. In circumstances where competitors can enter a market however, the real option holder would forgo any potential value from waiting to exercise so as to pre-empt competitors. Competitors entering a market can reduce the value of the cash flows from an investment made in that market, and therefore, the value of any investment opportunities.

While there are many issues associated with identifying and valuing real options, in the final analysis, the critical issue is to be able to think in terms of real options. Projects and investments can be conceptualized as portfolios of assets that have opportunities, option portfolios that can be managed dynamically as the future unfolds, uncertainty is resolved and new information becomes available. Real options analysis draws on a range of techniques that include market values, quantitative methods, and also, qualitative assessment. Even if objective market based valuations are not always obtainable, a qualitative interpretation of real options is essential, as a real options framework provides management with a structure for decisions that have to be made in any case.

2.3.6 Types of Real Options

Real options can exist in almost every business decision, although they are not always easily identified. Many types of real options have been recognized and analysed (Dixit and Pindyck (1994) and Trigeorgis (1996)), and the following is a summary of common categories:

Option to Defer The opportunity to invest can be more valuable than investing immediately, as it provides management with the flexibility to defer the

investment until conditions become more favourable, or to cancel completely if they become unfavourable. The opportunity to defer is the equivalent to a call option on the value of a project. These investment opportunities can still be beneficial even though the investment may have a negative NPV.

Option to Expand or Contract Options can exist in projects and operations to expand, to contract, and to shut down and restart. Management can expand production or increase resource deployment if the market environment develops more favourably than expected. This is the equivalent to a call option. On the other hand, operational scale can be reduced if market developments are less than initial expectations, which is the equivalent to a put option. The option to expand is specified as:

$$\text{Payoff} = \max\left[S_t - K, (1+x)S_t - K^*\right] \tag{2.2}$$

The option to contract is specified as:

$$\text{Payoff} = \max\left[S_t - K, (1+y)S_t - K^*\right] \tag{2.3}$$

Finally, the option to temporarily shut down is specified as:

(a) temporarily shut down operations:

$$\text{Payoff} = \max\left(S_t - VC, C\right) \tag{2.4}$$

(b) restart temporarily closed operations:

$$\text{Payoff} = \max\left(0, S_t - VC\right) \tag{2.5}$$

where,

S_t = initial underlying value
K = investment cost at t
K^* = K plus the increase (expand) or decrease (contract) in the investment cost at t

x = is the percentage increase in firm value
y = reduction in firm value
S = the project value
VC = variable costs
C = cash payout

Option to Abandon Management can abandon an operation if market conditions deteriorate, and liquidate any capital and other assets. The option to abandon is the equivalent to a put option. If the value of the asset or project falls below its liquidation value, the owners or holder of the option can exercise the put.

Option to Switch Management can change a project or an operation by restarting an operation that has been shut down, the equivalent to a call option; or shut the operation down, the equivalent to a put option. The cost of starting up or shutting down is the equivalent to the strike of the call or put. The option to switch is specified as:

$$\text{Payoff} = \left(S_1 - S_2 - CS, 0\right) \tag{2.6}$$

where,

S_1 = the NPV of the current operating mode one,
S_2 = the NPV of the current operating mode two,
CS = the cost of switching from the first to the second mode.

Growth Options Investments such as research and development, undeveloped land, oil and gas reserves, acquisitions and information networks can connect a chain of interrelated projects and create future growth opportunities, such as new products or processes and new markets.

Compound Options Projects frequently involve a collection of options, with combinations of upside value and downside protection present. The combined value of interacting options can differ from the sum of the separate parts due to their interaction. Some real options are relatively simple as their value, if exercised, is limited to the value of the underlying project. Other real options, however, can lead to further investment opportunities when exercised. These are options on options, or compound options, where the option payoff is another option.

Rainbow Options These are options that have multiple sources of uncertainty. Options that have payoffs that depend on two or more assets are called rainbow options. In the financial world, rainbow options can refer to the maximum or minimum of two or more assets, or other options, for example, where the payoff depends on the spread between two assets, the better of two assets and cash, portfolio options and dual strike options. In the case of real options, numerous sources of uncertainty can exist in the form of prices, quantities, technologies, regulation and interest rates.

2.4 Corporate Finance

2.4.1 Overview

Corporate finance has the objective of optimizing firm value while minimizing the associated risks. This encompasses the management of real assets that create firm value, minimizing the costs associated with the financing of these investments, and maintaining the firm's working capital.

Corporate finance is also framed within short- and long-term domains. The short-term domain focuses on a firm's working capital, defined as the net of current assets and current liabilities, and includes cash management, inventory and short-term lending and borrowing. The goal of working capital management is to optimize a firm's liquid assets. The long-term domain focuses on the capital investment decisions that involve a firm's fixed assets and capital structure. These decisions involve capital expenditure, the balance sheet debt and equity financing choices and dividend decisions. Capital investment decisions consist of an investment, a financing and a dividend decision, and are usually framed with the goal of maximizing firm value by investing in projects with a positive NPV.

Firm value is equivalent to the firm's total capitalization, which is equivalent to the market value aggregate of the firm's equity, bonds and any other claims, or the present value of all the claims on the firm. The value of the firm is therefore the present value of all free cash flows created from the firm's business model that are available to claimants on the firm. The concepts behind the analysis of real asset investments are equivalent for either the value for specific projects, or the firm itself, as the firm represents a collection of projects.

Capital structure is defined as the way in which a firm finances its balance sheet through the weighting of equity, debt and other security types. A firm's leverage is the ratio of firm debt to total financing. The goal of defining a firm's capital structure is to finance the assets so as to maximize firm value.

2.4.2 Theories of Firm Value

Initial theories of firm value were proposed by Miller and Modigliani, who examined the associations between a firm's operations in the real economy and its financing decisions in the financial economy. Miller and Modigliani showed that under an assumption of no taxes, firm value is the same, regardless of whether it is financed through equity or debt. The only impact the type of financing has is on the distribution of a firm's value between its investor types.

Miller and Modigliani also suggested that establishing firm value enabled the valuation of the firm's stock, bonds and other claims on the firm. A firm is represented by the present value of the firm's free cash flows discounted at a risk-adjusted interest rate, with the assumption that financing, the ratio of equity and debt, had no influence on the firm's operating cash flows and therefore on firm value. Once the value of the firm is established, the market value of debt is deducted to arrive at the firm's capitalization.

A firm's capital structure defines the manner in which it finances its assets and structures its liabilities, which include equity, debt and other claims. The Miller and Modigliani theory provides a foundation for the analysis of capital structure. Using the assumptions of perfect markets, no taxes, a universal borrowing interest rate, no bankruptcy or transaction costs and financing decisions not affecting investments, Modigliani and Miller drew two conclusions on capital structure. The first, defined as their first proposition, was that a firm's value is not influenced by capital structure. Their second proposition was that a leveraged firm's cost of equity is the same as that of a firm with no leverage. Miller and Modigliani later revised some of the assumptions—in particular, in regards to taxes.

The Modigliani–Miller theory provides a framework to examine how a firm's value is influenced by capital structure decisions and determining optimal capital structures. The Modigliani–Miller representation is defined as the primitive firm, for which its value is represented by the sum of the expected free cash flows discounted by the weighted average cost of capital. The primitive firm represents the DCF model of the firm, and provides a foundation for the analysis of a firm's financial structure through the financial options on the primitive firm.

Black, Scholes and Merton were the first to formalize the association between a firm's equity and debt. The insight was that equity can be defined as an option on a firm's assets, with the value of debt being equivalent to the residual of the value of assets over the value of equity. The Black and Scholes theory of the firm considered equity as a call option, with a strike equal to the

notional value of zero coupon debt, on the value of the primitive firm. Merton also considered equity as an option on a firm's assets to define the firm's debt value and credit risk. The model developed by Merton uses the value and volatility of the firm's assets and the notional value of debt.

Geske extended the Black and Scholes model by specifying a call option on the stock, which itself is an option of the firm's assets, or the equivalent to a compound option. Whereas the Black and Scholes model assumes that the volatility of a stock price is constant, the Geske model recognizes that volatility is not constant. The compound option model identifies volatility as a function of the level of the firm's stock price—or more fundamentally, on firm value. To achieve this, the Geske model adds an additional variable—the firm's notional debt—to the Black and Scholes model, as it is financial leverage that influences the volatility or risk of a firm's equity.

The next development in defining firm value focused on the actual firm as the underlying asset. Myers proposed that a firm's investments can be represented as options. Firm value had been defined as the primitive model, or a pool of projects that represents the present value of free cash flows. Investing in product markets can, however, produce cash flows from an initial investment, and value from growth options if a product market continues to expand. A firm's initial investments therefore provide a base for a sequence of potential follow-on investment decisions.

The identification of this time series of investments is an extension of the primitive firm, and these discretionary future investments were defined by Myers as real options, or options on real assets. Real options identify the investment decisions within a firm as a right without an obligation, or as state contingent decisions on real assets. A firm has the choice in the future whether or not to exercise the option on follow-on investments.

2.4.3 Developments in the Theories of Firm Value

2.4.3.1 Overview

The theories of the primitive firm, financial options and real options can be combined in a value framework that provides the flexibility required by a firm to adapt to its external environment. Copeland (2007) defines the combination as a 'three layer cake', with the primitive firm as the foundation, real options consisting of a portfolio of growth options and a firm abandonment option, and a portfolio of financial options. The three-layer framework identifies the relationships between a firm's real and financial options. A firm

has both an optimal real options investment structure and an optimal capital structure, with a trade-off between the two. The firm's operating and financial decisions, therefore, are not unrelated as per the Modigliani and Miller theory.

The following illustrates the components of the three layers which, when combined, offers a framework to manage firm value in a dynamic environment where both operating and financial flexibility are essential.

2.4.3.2 Primitive Firm Valuation

The primitive firm is defined as an underlying security that represents the firm's business risks. The firm's value, market capitalization, debt and other claims are defined as contingent claims on this underlying security—the primitive firm itself. The valuation of the underlying security is represented by the expected free cash flows to the firm, $E(\mathrm{FCF}_t)$ discounted at the cost of capital, w, with the assumption that systematic risk is the only risk factor. It is also assumed that the firm has no debt or other claims, is financed only with equity, and pays no taxes to segregate the tax issues from business risks. The value of the primitive firm, V is equal to V_0, the expected present value at $t = 0$:

$$E\left(V_t\right) = \sum_{t=1}^{N} \frac{E\left(\mathrm{FCF}_{i+1}\right)}{\left(1+w\right)^{i-t}} t = 0,1,\ldots.N. \tag{2.7}$$

The assumptions underlying the primitive firm are naïve, as firms will delay investments until uncertainty is reduced and also divest. These investment alternatives can be reduced to growth and expansion, defined as a European call option, or abandonment, or the equivalent to an American put option.

2.4.3.3 Growth Options

Given that it is possible to define the notion of a capital structure, it is also possible to define a firm's investment structure that includes its real options portfolio. This investment structure can be optimized to provide a firm the flexibility to adapt to its environment, and includes growth options, an abandonment option and a trade-off between scale and modularity.

The discretion a firm has on exercising its future investment opportunities is identified as call options on real assets. These options are growth options, and can be defined as a sequence of growth opportunities embedded in a firm's investments that have an impact on a firm's value.

Refer to the case study in Chap. 10 for an illustration of growth options.

2.4.3.4 Modularity

A firm's operational capacity is also a fundamental component of its investment structure. The firm has the option to expand capacity to meet increased demand, or not to expand if it has excess capacity. A firm's operating leverage is defined as the ratio of its fixed to variable costs. A high operating leverage is associated with less flexibility to adapt to change. Flexibility is therefore a function of a firm's operating leverage, and the capability to invest in modules has an impact on the firm's operating leverage.

The term 'modularity' is defined as a specific design structure where, within each unit or module, the parameters and tasks are mutually dependent, whereas across each module, they are independent. Modularity is a concept that can define a firm's operating leverage, or the degree to which the firm lacks operational flexibility due to its fixed costs. A firm's excess capacity is the variation between the firm's output capacity and expected output. The trade-off between modularity and economies of scale has an impact on a firm's excess capacity, and therefore, its investment and capital structure. Firm value can therefore be optimized through its investments in growth, abandonment and modularity.

Refer to the Appendix for an overview on modularity.

2.4.3.5 The Abandonment Option

A firm has value in the decision to discontinue operations and liquidate the firm's assets. This liquidation value is the equivalent to an option to abandon the firm to the firm's investors, with the exit value equal to the firm's total collateral or the total cash proceeds from liquidation. This option is an American put option, with the value of the option increasing as the value of the firm's total collateral or exit value increases.

Refer to the case study in Chap. 11 for an illustration of the abandonment option.

2.4.3.6 Financial Options

A firm's capital structure is defined by the financial options on the primitive firm as in the theories of Merton, Black and Scholes and Geske. The only decision variable in this case is the firm's debt policy, a choice that does not have an effect on primitive firm value. Under these assumptions, the same

value will be generated by a marginal investment, no matter what debt policy is selected.

2.5 Optimizing the Firm Structure

An optimal firm structure that provides the flexibility and capabilities to adapt to its external environment consists of the primitive firm, an optimal investment structure, modularity and an optimal capital structure. The optimal investment structure includes the real options in the European call option growth portfolio and the American put option to abandon the firm. A firm therefore has three layers that consist of the primitive firm, the real options portfolio and a capital structure consisting of debt and equity that is represented by financial options.

The variables of interest in an investment policy are:

- Capital structure, which is influenced by the trade-off between a firm's real options portfolio, debt ratio, and the tax benefits of leverage. Copland presents a model for an optimal capital structure using the variables described here.
- Modularity, which has a function in establishing a firm's investment structure. Flexibility in a firm's capacity provides the ability to adapt to changing markets and industries.
- Volatility, which creates value in real options along with a firm's ability to exercise these options. Volatility and flexibility also influence a firm's level of cash.

The variables of interest in an optimal financial structure are:

- The abandonment or collateral value, which has a positive relationship with firm value.
- A firm's debt policy, or leverage, which has an influence on growth and abandonment.
- Taxes, which will raise the value of the firm's equity if the balance sheet has debt that has tax benefits. This upside will however start to roll off or fall beyond a leverage threshold, and ultimately goes to zero if the firm is abandoned.
- Cash and cash management, which are related to flexibility. Firms with large cash reserves are able to react quickly to market and industry conditions, and exercise real options when compared to firms with higher debt

ratios and external funding requirements. Growth through expansion and abandonment are both influenced by the level of a firm's debt, or its leverage.
- Volatility, which also has an influence on the firm's financial option values. Increases in volatility will influence the firm's debt costs, and therefore the firm's capital structure.

A firm's investment and capital structure is ultimately a function of the industry in which it operates, its external environment and the firm's strategy. The interactions between a firm's investment structure, modularity versus economies of scale and capital structure create trade-offs in framing the firm's structure. Leverage will have an impact on the firm's equity when viewed as a call option on the firm's assets—and therefore, its growth and abandonment options. The use of tax to optimize a firm's capital structure will influence the flexibility of its operations. A firm's overall structure should therefore consider a range of variables and trade-offs when defining its capabilities to adapt to its environment.

Appendix: Modularity

The waves of innovation since the start of the industrial evolution have created an economic system that is increasingly sophisticated and complex. This economic system consists of objects that result from human intelligence and endeavours. These objects, or artefacts, include physical activities such as technologies and products, and intangible objects such as systems of law, organizations, strategies, science and designs.

Artefacts develop and evolve over time, as do the firms and markets that create and support these objects. These markets, technologies, products and firms evolve interactively to produce adaptive complex systems that ultimately become industries. An artefact is described by its design, and this designing of artefacts is a continuing process that accumulates at all levels to transform industries and economies.

Modularity is a theory of complex adaptive systems, design and industrial evolution that describes the creation of complex products and processes from smaller subsystems or modules that, although are independent in their design, nonetheless function together as a complete system. The modularity concept facilitates the management of complex systems by dividing them into smaller, more manageable components. This is achieved by creating a particular design structure with a set of design principles that separate the knowledge and tasks required for complex designs and artefacts.

The modularity concept has numerous applications, which include production scale and scope, mass customization and organization theory. An example can be found in computers, an artefact that has grown in complexity over the twentieth century. In the 1970s, the computer business evolved from a highly concentrated industry to modular clusters that manufactured components of larger computers systems. New designs created the opportunity for the emergence of new firms, which focused on manufacturing specialized components, or modules, that were linked by design rules for the creation of computer systems.

At the start of a modular design process, mandatory design rules are established for all stages of design and production. These design rules allow pieces of a modular system to be changed without the need to change the system as a whole. This capability creates the flexibility for the design to evolve at the module level, and therefore creates options for designers. These options provide opportunities for innovation and capabilities for firms to complete in today's environment.

In the twenty-first century the dynamics of global commerce will continue. The new technologies, markets, products and competitors that emerge from this process present both risk and rewards. In this context, modularity can address three issues—it increases the ability to manage complexity, it facilitates various components of a design to be worked on simultaneously, and it accommodates uncertainty. Modularity therefore offers the capabilities to manage the complexities and uncertainties in this environment, and provides a framework for creating value, growth and innovation.

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