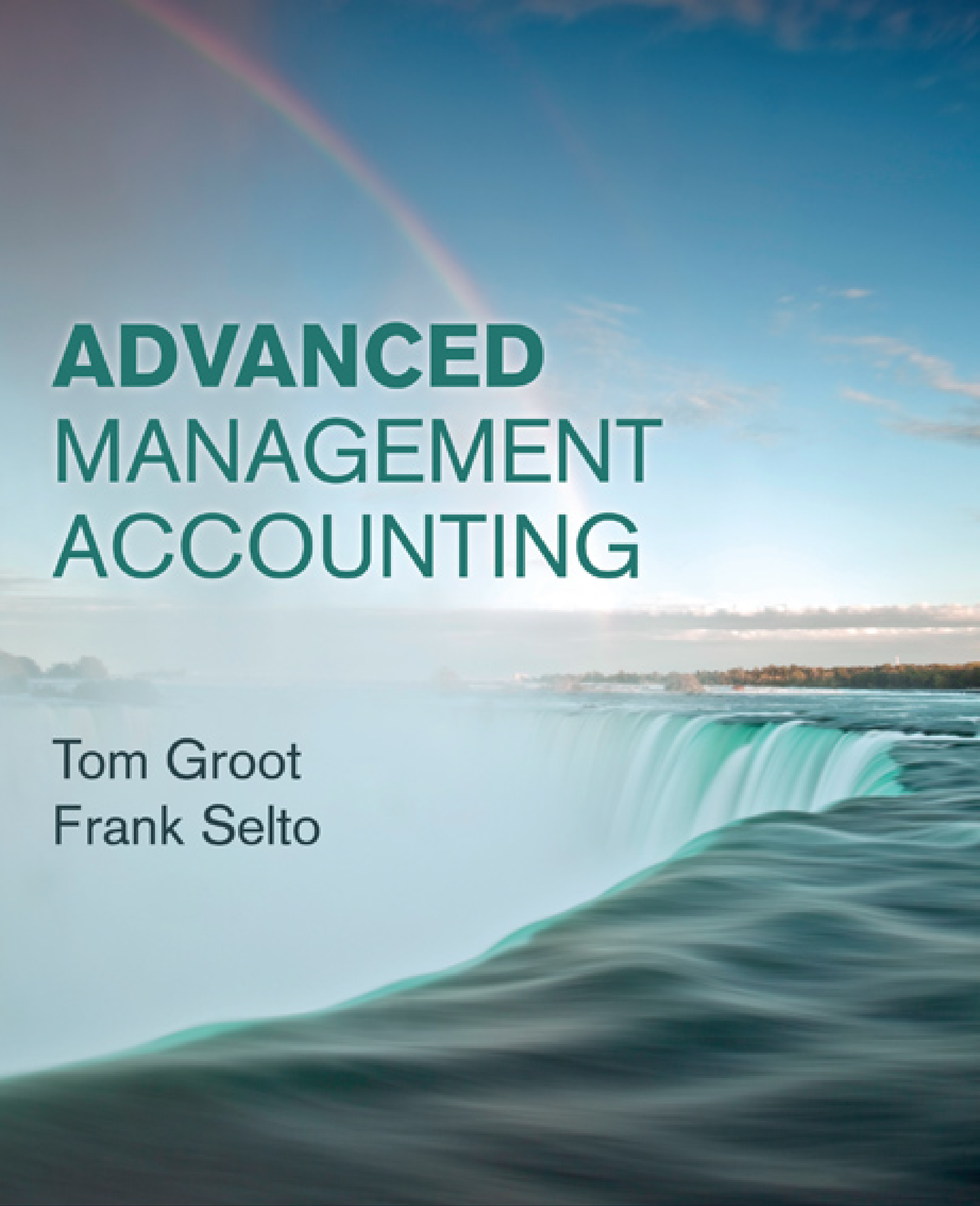

ADVANCED MANAGEMENT ACCOUNTING

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combines random values of each model input to randomise the financial model relations. This randomisation transforms a deterministic financial model, where risk must be teased out and may be never fully described, into a stochastic financial model which measures financial risk directly and perhaps fully.[27]

The Monte Carlo model can 'bootstrap' or repeatedly sample from the randomised variables thousands of times to create empirical outcome distributions that can answer such questions as, what is the probability of violating financial constraints? One can use the simulated distribution of outcomes to create confidence intervals or measure the probability of reaching (or failing) a targeted result. One also can observe the frequency and magnitude of extreme results (i.e. in the tails of the outcome distributions) that could be catastrophic if realised.

IAM's financial analyst developed a Monte Carlo risk analysis of the Refrigerator Division by adapting the Division's business model to include randomised drivers of the costs and revenues that drive all of the modelled financial outcomes. The first step is to specify the probability distributions for the randomised drivers. Sufficient reliable evidence exists to measure the historical means and standard deviations of 'annual growth' in unit sales and sales prices, 'first-year conventional unit sales' and 'sales price'. The analyst has determined that the historical distributions were indistinguishable from Normal distributions. The marketing research team has drawn on past new product introductions to estimate subjectively the means and standard deviations of Nano's 'first-year unit sales' and 'sales price'. The team assumes that these, too, are 'Normally' distributed and conservatively assumed that Nano sales would grow at the same rate as conventional products. The estimated distribution parameters are in rows 3 and 4 of Figure 4.14.[28] The Monte Carlo analysis randomly selects values from these five probability distributions for each occurrence of these inputs in the Division's financial model.[29] Thus, every calculation and subsequent outcome in the model that uses these inputs directly or indirectly is randomised, too.

ProForma Financial Statements - Refrigerator Division Monte Carlo Analysis					
Randomised Variables	Annual Growth	Conventional 1st Yr Sales	Conventional 1st Yr Price	Nano 1st Yr Sales	Nano 1st Yr Price
Mean input values	3.0%	2,000	13,200	100	2,000
Estimated Standard Errors	1.1%	365	611	20	100
Simulated Key Financial Ratios, Refrigerator Division	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Current ratio - Target	2.000	2.000	2.000	2.000	2.000
Current ratio - Pro Forma	1.299	1.297	1.735	2.393	3.074
Interest coverage ratio - Target	2.000	2.000	2.000	2.000	2.000
Interest coverage ratio - Pro Forma	5.901	10.328	40.996	#DIV/0!	#DIV/0!
Debt to value ratio - Target	0.500	0.500	0.500	0.500	0.500
Debt to value ratio - Pro Forma	0.412	0.289	0.217	0.201	0.184

Figure 4.14 Monte Carlo analysis

[27] Observe that this shifts the concerns of sensitivity analysis from the values of the model inputs to the values of the distribution parameters (means, standard deviations) of the model inputs.

[28] For economy of presentation, we do not present the fully randomised Monte Carlo model that uses probability distributions for all of the financial model's uncertain inputs.

[29] The values in the model are replaced by the Excel function NORMINV(RAND( ),mean, standard deviation). The nested RAND() function creates a random variable between 0 and 1, so each calculation of the input value is random and distributed with the input's mean and standard deviation. Excel has other probability distribution functions that could be used, as appropriate.

The simulated financial ratios in rows 7 to 12 are similar to those presented in Figures 4.11 to 4.13. The key difference is that the previous Figures were computed with deliberately chosen input values that represented managers' beliefs about most likely, best and worst case scenarios. These three scenarios do not exhaust the possible input sets, and they might reflect limited or biased knowledge about future inputs. Monte Carlo analysis expresses managers' knowledge of future inputs as probability distributions from which input values are selected randomly, without bias. However, a single draw of randomised inputs is just that, a single draw. There is no reason to believe that the financial ratio outcomes in Figures 4.14 from a single, random draw reflects future financial ratio outcomes any more reliably than one of the earlier scenarios. One could argue that the outcomes of a single random draw are less reliable that a manager's judgment of a likely scenario. The real power of Monte Carlo analysis comes from its ability to make thousands of random, simultaneous draws from the input probability distributions. What results is a simulated probability distribution of future outcomes, and it can have as many observations as one's computer can produce.

IAM's financial analyst followed these steps and used Microsoft Excel on a PC to adapt the Division's financial model for Monte Carlo analysis and to create a series of simulated outcomes:

1. Type ‘Simulations’ in a blank cell.
2. Type 1 in the cell below it; fill in as many numbers below it as the number of desired simulation runs (use Editing/Fill/Series/Column as a shortcut).
3. To the right of the number 1 type the cell reference(s) to the results you wish to simulate (e.g. sales units, annual growth, debt to value ratio,. . .).
4. In the ‘Formula’ menu select ‘manual’ under ‘Calculation Options’.
5. Select the area to hold your simulated results, including **all** numbered rows (e.g. 1000 or more rows)
6. Under the Data bar select What-If Analysis/Data Table and choose the blank cell below the numbered column for the ‘Column input cell’ (nothing for the ‘Row input cell’).
7. Hit the F9 key to generate a new set of simulated results (Table 4.4) – only the first several simulations are shown.

Table 4.4 Year 1 simulation results

	Conventional sales units	Nano sales units	Annual growth	Debt to value Ratio
Maximum	3,227	105	4.538%	0.810
Minimum	741	96	−4.157%	0.246
Percent that exceed ratio constraint			0.500	53.4%
Percent that mark insolvency			1.000	0.0%
Simulations	**Conventional sales Units**	**Nano sales units**	**Annual growth**	**Debt to value Ratio**
1	**2,235**	**101**	**1.132%**	**0.358**
2	1,911	98	−1.539%	0.619
3	2,434	101	0.885%	0.333

(Note that Excel for Macintosh computers works slightly differently. Also note that commercial Monte Carlo simulation add-ins for Excel, which greatly simplify this procedure, may be available at student pricing.)

The excerpt from the simulated series for the first year results is repeated for each of the five years of the analysis horizon. For this example, the drivers and the debt to value ratio have been simulated 1000 times for each of the five years. Maximums and minimums are recorded for each. Importantly, the analysis provides a simulated probability of violating the debt to value ratio constraint (must be less than 0.500) and the probability of insolvency (debt exceeding book value of total assets, or negative stockholders' equity). These are important considerations, especially as they unfold in the simulated five-year horizon. Consider the summary of these two statistics in Figure 4.15, which displays answers to the questions: What is the probability of the Division's violating the debt to value constraint? What is the probability of the Division's becoming insolvent?

The probability of violating the debt to value constraint declines over time, but still seems quite high. More alarming perhaps is the probability of insolvency, which rises steadily and quickly during this horizon. The uncertainty about future growth and profitability grows and

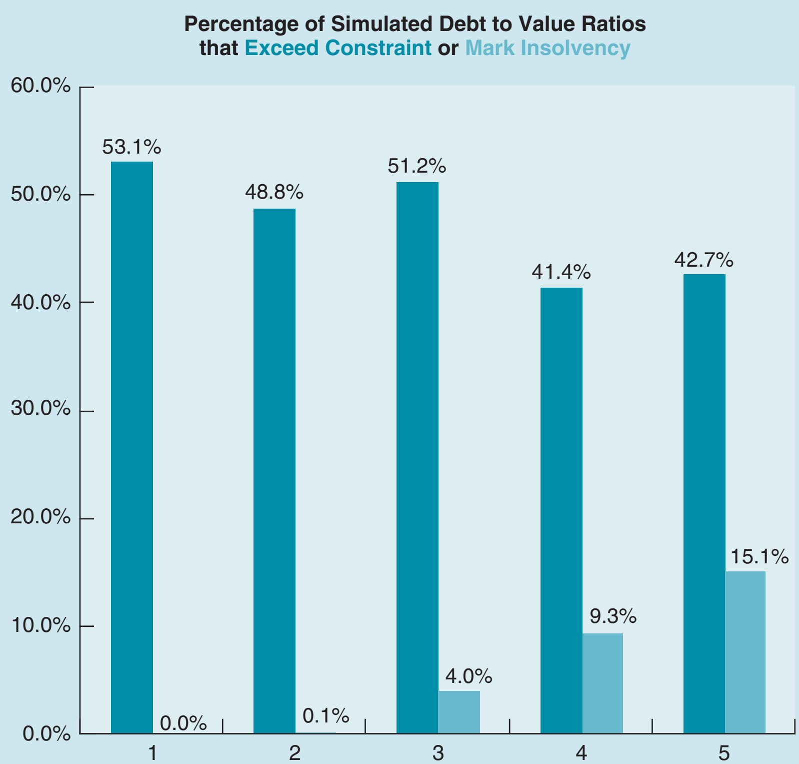

Figure 4.15 Summary of statistics

surfaces ultimately as a rather high probability of insolvency, which begins to look more like the 'worst case' scenario of the previous sections than the 'most likely case.'

Whether these concerns are worthy of attention can be traced directly to the estimated probability distributions for the drivers of costs and revenues. Surely if these are unreliable, the simulated financial outcomes are unreliable. One might anticipate that disparagers of these uncomfortable results will challenge the probability distributions, but if these are shown to be reliable, IAM needs to pay attention to the simulated results. Perhaps adverse outcomes are likely and deserve management attention, perhaps even to the point of divesting this division. If the inputs are reliable, this Monte Carlo analysis should trigger investigations of the long term viability of the Refrigerator Division and its new products. These investigations should focus on refining estimates of the probability distributions of model inputs.

EXAMPLE FROM PRACTICE

Actuaries are common users of 'dynamic financial analysis' (DFA) models that simulate investment and underwriting risks. Actuaries stress the key insight that DFA models might not predict absolute outcomes precisely (i.e. a specific financial ratio level) but they are useful to assess relative risks. That is, DFA models can be used to predict whether a company will be better or worse off by accepting a particular risky endeavour. Another key insight is that actuaries can communicate relative risks to investment managers more effectively when using a DFA that mimics projected financial results.[30]

4.4 Recap of financial modelling

Financial modelling can be a useful aid to strategic decision making and operational planning. Many cross functional management and project teams have (or need) a financial analyst who creates financial models of business problems and solutions. Financial modelling is a key component of strategic planning risk assessment, and project management. Reliable financial models can serve as important management training tools. The methods presented in this chapter describe key elements of financial modelling that offer benefits to individuals who gain and use this knowledge and to their organisations that benefit from expanded analyses of financial outcomes and risks of not meeting financial goals.

[30] Sclafane, S. 2000. 'Dynamic Financial Analysis.'

Key recommendations for successful financial modelling include:

1. Design financial models to reflect the context and drivers of management decisions.
2. Spend the time necessary to refine estimates of input values and their distributions.
3. Build financial models to the point that they can be used as reliable Monte Carlo simulations that inform and assess value and financial risk

EXERCISES

Exercise 4.1 CVP model and time to break-even

Larsen Building Co. owns land in an urban area that is zoned for commercial use. Larsen plans to construct and rent a 50 000 square foot commercial building on the site. Larsen is considering whether to design a building that meets criteria for LEED platinum certification (**http://www.usgbc.org**), which has marketing and sustainability advantages in the current commercial real estate market. Larsen expects normal construction to meet local needs and buildings codes will cost $275 per square foot. Because of the urban location, meeting the LEED platinum certification is expected to add 8% to construction costs. However, if the commercial building is successfully certified, Larsen can qualify for a one time, combined federal and state 'green' tax credit of $2.20 per square foot. Uncertified commercial property in the vicinity rents typically for $20 per square foot per month, but, because renters can market their 'green-ness' and more easily pay for utilities, the occupancy rate for LEED certified properties can increase from 70% to 85%, despite rents that are 10% higher.

Annual maintenance costs for non-certified buildings in the area average $3.00 per square foot, while the cost to maintain LEED buildings can be 1/3 less costly. Larsen's effective tax rate is 30%. The building 's expected life is 40 years with no salvage value. Ignore other expenses and the time value of money.

Required:

1. What qualitative factors should Larsen Building Co. consider before deciding whether to seek LEED certification?
2. Prepare a financial model to answer the question whether it is worthwhile building to the LEED certification or not.

Data input	Non-LEED	LEED certified		
Building size	50 000		50,000	square feet
Construction cost	$275.00	8%	$297.00	per square foot
Green tax credit	—		$2.20	per square foot
Rent	$20.00	10%	$22.00	per square foot
Occupancy rate	70%		85%	
Maintenance	$3.00	−0.333333333	$2.00	per square foot
Tax rate	30%		30%	
Building expected life	40		40	years

Exercise 4.2 Profit planning model

Flying-A Ranch is a former cattle ranch that the owners have converted to an exclusive guest ranch. The ranch offers daily horseback riding, hiking, fishing and just relaxing to a maximum of 14 guests per week. The weekly fee covers costs of all meals, horseback riding and unguided fishing and hiking. A few other ranch activities are offered at modest cost, and guests may contract with other tourist entities for off ranch tours. The table below contains data concerning a typical four month ranch season. Because of its remote location and severe winters, the ranch is closed to guests for the remainder of the year.

Required:.Use the data input to prepare a profit planning model for a typical season.

Data input				
Weeks per month	4			
Meals provided per week per guest	21			
Double occupancy, rate per week per guest	$ 2000			
Single occupancy, rate per week per guest	$ 3000			
Guest ranch season	**June**	**July**	**August**	**September**
Double occupancy, guests per week	8	12	12	10
Single occupancy, guests per week	2	1	1	2
Other activities per guest, per week	**Charge**	**CM ratio**	**Proportion of guests**	
Souvenirs	$ 40.00	50%	80%	
Flyfishing	10.00	80%	50%	
Skeet and trap shooting	25.00	40%	20%	
Off-ranch tours (offered by other entities)	300.00	20%	10%	
Costs per guest				
Cabin maintenance per week	50.00			
Food cost per meal	10.00			
Monthly facility costs				
Wranglers (3)	6000			
Kitchen staff (3)	5000			
Cabin maintenance staff (1)	1500			
Horses and tack	12 000			
Maintenance of equipment and vehicles	2500			
Utilities	2000			
Insurance	3000			
Legal and accounting services	2000			
Depreciation of buildings, equip. and veh.	5000			
Income tax rate	30%			

Exercise 4.3 CVP model

Refer to the narrative and data input for Exercise 4.2. The owners have been offered $12m for the ranch. They expect to operate the ranch for ten more years, before retirement.

Required:

Use the results of Exercise 4.2 and quantify the implications of refusing the offer.

Exercise 4.4 Profit planning model and CVP

The City of Rock Ridge is considering building and operating a small event centre that can host second and third level professional sporting events and music concerts. Rock Ridge must balance its budget each year and cannot subsidise activities like this; that is, the event centre must be self-sustaining. Although the city can borrow funds to finance the construction of an event centre, the centre must be profitable enough to retire its