CHAPTER 3

The Decision Usefulness Approach to Financial Reporting

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LEARNING OBJECTIVES AND SUGGESTED TEACHING APPROACHES

1. Decision Usefulness

The main purpose of this Chapter is to provide a framework for understanding the concept of decision usefulness of financial reporting. Consistent with SFAC 1, I assume that the major decision problem to which financial reporting is oriented is the investment decision. I then argue that if accountants are to produce financial statements that are useful for investment decisions, they need to understand how rational investors make such decisions.

2. Single-person Decision Theory

I use this theory, including the revision of beliefs by means of Bayes’ theorem, as a model of rational investment decision making. Prior to getting into the theory itself, I usually discuss with the class how they would proceed to make investment decisions if they had a sum of money to invest, and steer the discussion to make the point that single-person decision theory provides a systematic and formal way to do what many of them would do anyway. Some instructors and students may disagree with this argument, in view of increasing acceptance by academics that securities markets are not fully efficient, and that investors may not be rational in an economic sense. These issues are discussed in Section 6.2. I argue there that the rational investment decision model can explain security price behaviour that is often attributed to non-rational investor behaviour, and that securities markets are sufficiently close to full efficiency that the efficient markets model is still the most useful one to use for studying the
information needs of investors. I also argue that to the extent securities markets are less than fully efficient, the scope for decision useful information is increased.

Contrary to my usual rule, I stick quite closely to the text when illustrating the decision theory model, since this model and the concepts that go into it are new to most students. I go over in detail either the text example or some other similar example such as one of the end-of-chapter problems. I always end up by asking the class how realistic they think the model is (see point 4 below for additional discussion). If a student is particularly critical, I fall back on asking again how he or she would make an investment decision under similar circumstances. I do not particularly try to defend the extent to which the model can be operationalized. However, as stated above, I do make the argument that whether it is operational or not, it is a very useful conceptual device to help us understand what information is and how investors may find financial statement information to be useful.

3. The Concept of an Information System

This is one of the most important concepts in the text. While the idea of the financial statements being represented as a table of objective, conditional probabilities may take some getting used to, the information system provides the crucial link between current reported performance and the future performance of the firm. It captures the quality of the financial statements with respect to their usefulness for investment decisions.

Many reporting issues can be conceptualized by their effect on the main diagonal probabilities of the information system. For example, a switch from historical cost to current value accounting, or earlier recognition of revenue, increases these probabilities by increasing relevance. This tightens up the relationship between current and future performance and, other things equal, increases decision usefulness. However, to the extent that fair value accounting and early revenue recognition are less reliable than historical cost, this would have the opposite effect on the main diagonal probabilities. The net effect on decision usefulness is thus not clear, but the information system is helpful in conceptualizing the nature of the tradeoffs in accounting policy choice and the concept of earnings quality—higher main diagonal probabilities, higher quality. Earnings quality comes up again in Section 6.4.
I find that the students’ understanding of the information system is helped if the instructor spends some time on the two extremes — a perfect system and a useless system. See Problem 1 of this chapter. This problem pushes understanding by showing what happens when state probabilities are revised by Bayes' theorem using the conditional probabilities from the perfect and from the useless information systems.

I have structured the states of nature in Example 3.1 in terms of future firm performance, rather than some more primitive states such as good economy or bad economy. Future firm performance can be conceptualized in terms of future cash flows, earnings, or dividends.

Many discussions and models of firm performance and value are based on expected future cash flows, particularly in the finance literature. I include future earnings as an alternate measure of performance and value to be consistent with Ohlson's clean surplus theory, which is discussed in Section 6.5. The Ohlson theory shows that the market value of the firm can equally be expressed in terms of expected future dividends, cash flows or financial statement variables. Since this is an accounting text, it seems natural to take financial statement variables such as earnings as a fundamental determinant of firm performance and value, on an equal footing with cash flows and dividends. Also, because of the Ohlson theory, prediction of future earnings is becoming more common in empirical accounting research. Empirical implications of clean surplus theory are discussed and illustrated in Section 6.5.
4. Does it Work?

While, as stated above, I do not particularly try to defend the decision theory model as an operational way to make decisions, I do spend some time discussing with the class whether they would be willing to make an investment decision this way. The following notes, which could be distributed to the students, discuss some of the issues in applying the procedure.

Issues in Applying the Decision Theory Model

Specifying the states of nature. States of nature are specific to the decision problem at hand. For example, if my decision is whether or not to take my raincoat, relevant states would be rain or no rain. That is, the relevant states of nature are simply those random events whose outcome matters to the decision at hand. In an investment context, these can be taken as different levels of future firm performance, since it is future performance that determines investment payoff.

Specifying prior probabilities of the states of nature. These capture everything the decision maker knows up to the beginning of the decision analysis. There are techniques to help specify these probabilities. One technique is to conceptualize an urn containing 100 coloured balls, of which a certain number are red and the remainder black. To illustrate, suppose an investor wants to assess his/her prior probability of high future firm performance next year. Envisage a bet of, say, $50 on this state—if future performance is high you win $50, otherwise you lose $50. Now consider another bet. You will draw 1 ball from the (opaque) urn. If you draw a red ball you win $50, otherwise you lose $50. How many red balls should there be in the urn so that you are indifferent between the 2 bets? Suppose you decide you would be indifferent if the urn contains 6 red balls. Then, your subjective probability of high future firm performance is 0.06.

Since prior probabilities are subjective, we cannot say that this probability is “correct.” The point is, however, that in deciding on the number of red balls you are forced to consider everything you know about the firm’s future prospects.

Specifying payoffs. For each state of nature, specification of your payoff if a particular state happens should be relatively straightforward. For example, suppose you invest
$10,000 in shares of X Ltd. and the high performance state happens. Analysis of past share price behaviour of X Ltd. when the firm is performing well may reveal an average share return of 16%, that is, a net payoff of $1,600.

Of course, if you decide to invest your $10,000 in a riskless asset instead, the states of nature for X Ltd. do not affect your payoff—if you buy a government bond yielding 2\(\frac{1}{4}\)%, your payoff will be $225 regardless of X’s performance. That is, states of nature only apply to decisions with uncertain payoffs. Nevertheless, in deciding between a risky and a riskless investment, you need to evaluate the payoff from the risky asset even if your decision turns out to be to buy the riskless one. In other cases, your decision may be between 2 or more risky investments. Then, the same set of states applies to each possible investment. Text problems 11 and 17 illustrate this situation.

Specifying your utility function. Since most decision makers are risk averse, the expected utility of a risky payoff depends on how risky it is. The text uses the device of a utility function to calculate expected utility. There are techniques available to interrogate yourself to estimate your utility function. A related approach is to estimate your expected utility for a given risky investment directly. For example, suppose you are facing a gamble of a 0.30 probability of a payoff of $1,600 and a 0.70 probability of a payoff of zero. Ask yourself, what certain payoff would you need to be indifferent between this payoff and the risky gamble just described? Suppose you feel the certain payoff is $200. Then, you would use $200 as your expected utility for the risky gamble. If an alternative investment yields a certain payoff of $225, your expected utility for this “gamble” is $225, since no risk is involved. Then, you would choose the riskless decision alternative.

Versions of this approach are used by investment advisors, who ask clients whether their tolerance for risk is low, medium, or high.

The information system. If you decide to gather more information before acting, specification of the information system is the most difficult aspect of your decision problem. Unlike prior probabilities, information system probabilities are objective. If your additional evidence is to be obtained from financial statements, the information system probabilities are determined by the quality of GAAP. Thus, if X Ltd. is in the high
performance state, the probability that the financial statements show GN will be higher the higher is the quality of GAAP. Nevertheless, it is still possible that the financial statements show BN since GAAP cannot completely rule out errors and biases in accounting estimates.

One approach to estimating information system probabilities is to use a sampling approach to analyze the past relationship between financial statements and subsequent firm performance. When past financial statements have shown GN, how many times has next year’s firm performance been high, etc.? Another approach is to estimate information system probabilities based on analyst reaction to the financial statements, as outlined in Section 3.3.2 of the text. The stronger is analyst reaction per dollar of GN or BN, the higher the information system main diagonal probabilities.

Conclusion. You may feel that there are so many issues surrounding the inputs into the decision theory model that the procedure is not viable. If so, ask yourself how else you would make a decision under uncertainty. By forcing careful consideration of the variables that really matter to a decision, the decision theory approach may well lead to better decision making on average.

Of course, you may instead turn your decision making over to an expert, such as a financial institution or advisor. However, if you do, you still face a decision problem—which financial advisor, how much to invest, do you accept the advisor’s advice, etc. The issues described above still apply.

Finally, whether or not you accept the model, a major argument of Chapter 3 is that the model reasonably captures the behaviour of the average investor, even though individual investors may not follow the procedures exactly. As such, the model provides guidance to accountants about the information needs of investors and the crucial role of information in facilitating these decisions.
5. Portfolio Theory and the Optimal Individual Investment Decision

The text then goes on to illustrate a number of standard concepts and results from portfolio and investment theory in Sections 3.5 to 3.7, incl. In response to several comments from users of earlier editions about the technical nature of much of this material, I have added a note in the text that this material can be skipped without substantial loss of continuity, and have made some small changes in the following chapters as a result.

I treat this material, Sections 3.5 to 3.7, as a specialization of single-person decision theory to the investment decision. The main point I make is that the theory implies that useful information is information that helps investors estimate expected returns and betas (i.e., risk) of securities.

Other than a brief, intuitive discussion of risk aversion in Section 3.4, I usually do not spend much class time on the material in Sections 3.4 to 3.7. Many students will already have seen this theory in other courses. For those who have not, the text discussion is designed to be self-contained, with liberal use of a running example.

6. Back to the Real World

At this point, it is important to bring the students back to the "real world" of accounting. I do this by demonstrating that the FASB, in its conceptual framework, has “bought” the rational decision theory approach. The extent to which the IASB and CICA have accepted this approach is less clear. A look at the extracts from the IASB Framework and Section 1000 of CICA Handbook shows that they stop short of recognizing the rational investor as the main financial statement user. Since “true” net income does not exist, and since different users have decision needs, it is not clear to me how a single set of financial statements can cater to different user constituencies. Consequently, I concentrate on discussing the FASB framework in the text, since I feel that it is on a more solid theoretical foundation. The IASB and FASB are working to reconcile their conceptual frameworks. It will be interesting to see how this reconciliation eventually turns out.
I usually hand out the Highlights and Summary of SFAC 1 and 2 of the FASB. I spend class time illustrating and emphasizing the text discussion in Section 3.8, where consideration of various key words in SFAC 1 and 2 shows that the investment decision theory lies just under the surface. This demonstration is important not only because it exposes the students to important underlying conceptual components of professional accounting standards-- it also helps to motivate serious student consideration of the theory itself.

Some instructors may be interested in the route by which such an abstract theory as the theory of rational decision entered into the FASB concepts statements. The source appears to be the American Institute of Certified Public Accountants Study Group on the Objectives of Financial Statements, “Objectives of Financial Statements,” (New York, NY: AICPA, 1973), also known as the Trueblood Report. According to Zeff in his article “The Evolution of the Conceptual Framework for Business Enterprises in The United States,” (Accounting Historians Journal (December, 1999)), the Trueblood Report provided a “blueprint” for the FASB concepts statements. This can be seen with particular clarity in Volume 2: Selected Papers of the Trueblood Report, which contains several studies on the use of accounting information in normative models of investor consumption/investment decisions. See, in particular,


SUGGESTED SOLUTIONS TO QUESTIONS AND PROBLEMS

1. Perfect or Fully-Informative Information System

Current Financial Statement Information

<table>
<thead>
<tr>
<th>State of nature (future profitability)</th>
<th>GN</th>
<th>BN</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Low</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

Here, each state produces a different message with probability 1. Thus, if the state is H, the financial statements will show GN for certain, and so forth.

Prior probabilities of the states of nature are:

\[ P(H) = 0.30 \]

\[ P(L) = 0.70 \]

(any other set of prior probabilities with \( P(H) > 0 \) would do)

Suppose that GN is observed. Then, by Bayes' theorem:

\[
P(H \mid GN) = \frac{P(H)P(GN \mid H)}{P(H)P(GN \mid H) + P(L)P(GH \mid L)} = \frac{0.30 \times 1.00}{(0.30 \times 1.00) + (0.70 \times 0)} = 1.00
\]

\[
P(L \mid GN) = \frac{P(L)P(GN \mid L)}{P(H)P(GN \mid H) + P(L)P(GN \mid L)} = \frac{0.70 \times 0}{(0.30 \times 1.00) + (0.70 \times 0)} = 0
\]
Thus, with a perfect information system, the information perfectly reveals the true state of nature.

If BN is observed, similar calculations give $P(H/BN) = 0$, $P(L/BN) = 1$.

**Non-Informative Information System**

Current Financial Statement Information

<table>
<thead>
<tr>
<th>State of nature (future profitability)</th>
<th>GN</th>
<th>BN</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>0.8</td>
<td>0.2</td>
</tr>
<tr>
<td>Low</td>
<td>0.8</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Here, both rows of the information system are the same. Any system with both row probabilities the same would do.

Note: Students have a tendency to use 0.5 probability in each row. This is OK, but instructors may wish to point out that other probabilities, such as those used above, also produce a non-informative system as long as the probabilities in each row are the same. More generally, the information system is non-informative if the row probability vectors are linearly dependent.
Suppose that GN is observed. Then, by Bayes’ theorem:

\[
P(H / GN) = \frac{P(H)P(GN / H)}{P(H)P(GN / H) + P(L)P(GN / L)}
\]

\[
= \frac{0.30 \times 0.80}{(0.30 \times 0.80) + (0.70 \times 0.80)} = 0.30
\]

\[
P(L / GN) = \frac{P(L)P(GN / L)}{P(H)P(GN / H) + P(L)P(GN / L)}
\]

\[
= \frac{0.70 \times 0.80}{(0.30 \times 0.80) + (0.70 \times 0.80)} = 0.70
\]

The posterior probabilities are the same as the prior probabilities in this case, which is what we would expect if the information system is non-informative. That is, regardless of which is the true state, the state probabilities are the same after the financial statements as before. In effect, the information cannot discriminate between states. Thus, it is non-informative, or useless.

A similar result holds if BN is observed.
2. The utility function of a risk-taking investor would appear as the solid line below:

Compared with Figure 3.3, the utility function is convex, rather than concave. Thus, as the payoff \( x \) increases, utility increases at an increasing rate, rather than at a decreasing rate.

A specific example of a risk-taking utility function is:

\[
U(x) = \frac{x^2}{10,000}
\]

yielding the utilities shown on the vertical axis of the above figure.

Consistent with Example 3.1, suppose a risky investment offers a payoff of $1,600 with probability 0.30 and $0 with probability 0.70, giving an expected return of $480. Our risk-taking investor's expected utility for this investment is

\[
256 \times 0.30 + 0 \times 0.70 = 76.80
\]

The utility of the risk free investment, which offers a payoff of $225 for sure, is only 5.0625. Thus, for the same prior probabilities and payoffs, the risk-taking investor prefers the risky investment whereas Bill
Cautious, who is risk averse, prefers the risk-free investment.

A risk-taking investor will *specialize* (that is, buy only one security) — the one with the highest risk for a given expected return. There is no incentive to diversify for an investor who *likes* risk.

A risk-taking investor needs the same information as any other investor — information that will be useful in assessing expected returns and risks of securities. However, risk-taking investors will use the information differently. They will seek to find the securities that, for a given return, have the highest risk.

3. For \( a_2 \) to yield the same utility as \( a_1 \), we must have:

\[
3\bar{x}_{a_2} - 1/2\sigma_{x}^2 = 2.384
\]

\[
3 \times 0.80 - 1/2\sigma_{x}^2 = 2.384
\]

Solving for \( \sigma_{x}^2 \):

\[
1/2\sigma_{x}^2 = 2.400 - 2.384 = 0.016
\]

\[
\sigma_{x}^2 = 0.032
\]

A risk-averse investor trades off risk and expected return. An investment act with a lower expected return must also have lower risk if it is to give the same expected utility. As shown in the calculation, the risk of \( a_2 \) (0.032) is less than that of \( a_1 \) (0.512) in order to compensate for the reduction in expected return from 0.88 to 0.80.
4. From Figure 3.5, we have:

\[
\begin{align*}
\text{at } Z: & \quad \bar{x} = 0.1075, \quad \sigma^2_x = 0.0020 \\
\text{at } M: & \quad \bar{x} = 0.0850, \quad \sigma^2_x = 0.0009
\end{align*}
\]

Toni’s utility at Z: \( U_i (Z) = \frac{1}{2} \times 0.1075 - 16 \times 0.0020 = 0.0218 \)

Toni’s utility at M: \( U_i (M) = \frac{1}{2} \times 0.0850 - 16 \times 0.0009 = 0.0281 \)

Thus, Toni no longer prefers Z over M, as she did in the illustration of Figure 3.5, because she is now more risk averse. She therefore would not want to increase her risk by borrowing at the risk-free rate to buy more of the market portfolio. (In fact, she would probably want to reduce her risk, say, by moving to point Y in Figure 3.5.)

5. a. The beta of the market portfolio is 1, since the covariance of a random variable with itself is the same as its variance.

b. The beta of the risk-free asset is zero. The return on the risk-free asset is a constant and the covariance of a random variable with a constant is zero.

c. We can think of portfolio A + B as a single asset and calculate the covariance of its payoffs with those of the market portfolio much like we would for a single security. However, a simpler way is to use the fact that the beta of a portfolio is a weighted sum of the betas of the securities in the portfolio.

From Example 3.3, Toni invests $200: $120 in A, and $80 in B. Therefore, the weights of each security in the portfolio are:

\[
\begin{align*}
A: & \quad \frac{120}{200} = 0.60 \\
B: & \quad \frac{80}{200} = 0.40
\end{align*}
\]
The betas of each security are given in Section 3.7.1:

\[ \beta_a = 2.6667 \]

\[ \beta_b = 1.5556 \]

Then:

\[ \beta_{a+b} = 0.60\beta_a + 0.40\beta_b \]

\[ = 0.60 \times 2.6667 + 0.40 \times 1.5556 \]

\[ = 1.6000 + 0.6222 \]

\[ = 2.2222 \]

6. The variance of the return (that is, the risk) of a portfolio is a weighted sum of the return variances of the securities in the portfolio and the covariances of the returns for each pair of securities in the portfolio (these are called “pairwise covariances”). As the number of securities in the equally weighted portfolio (n) increases, the weights attached to each security variance \(1/n^2\) decreases. Due to the \(n^2\) term in the denominator, the weight rapidly decreases as n increases. This rapid decrease captures the fact that firm-specific risk (a security’s variance is a measure of its firm-specific risk of return) diversifies away as the number of securities in the portfolio gets large. Since \(1/n^2\) becomes quite small for as few as \(n = 10\) securities, most of the benefits of diversification can be attained with relatively few securities.

No, the risk of return does not approach zero as the number of securities in the portfolio gets larger. This is because the returns on the securities are correlated, due to economy-wide or systematic risk, which affects the returns on all risky securities. Then, the portfolio variance also includes all the pairwise covariances of return of the securities in the portfolio. While the weights attached to these
covariance terms \( \left( \frac{2}{n^2} \right) \) also decrease with \( n \), the number of covariance terms increases rapidly \( \left( \frac{n(n-1)}{2} \right) \). Thus, unlike the variance terms, the sum of the covariance terms does not decrease to zero as \( n \) increases. This sum captures the systematic risk of the portfolio, which cannot be diversified away.

7. The argument is probably made because of the lumpiness of certain cash receipts and disbursements. Cash payments for major purchases such as capital assets, and for borrowings such as loan proceeds, tend to occur at discrete intervals in large amounts. As a result, a firm could have what appears as a favourable cash flow, but one which results, for example, from the proceeds of a large borrowing rather than from recurring operating transactions. Since financial statement users are primarily interested in the firm’s ability to generate cash from operations, it would be necessary to separate out the effects on cash flows of major transactions such as these.

Even within the category of operating cash flows, there can be lumpiness of receipts and payments -- for example, a large collection on account may come in shortly after year end. Under a strict cash basis, this would not appear as a cash flow in the year. Under accrual accounting, of course, the account receivable (an accrual) and revenue from such a transaction would be included in the financial statements regardless of whether the cash was collected yet or not.

In effect, the FASB seems to be arguing that accrual accounting enables a better prediction of average or longer-run future operating cash flows or, more generally, of future firm performance, by recording the inflows (revenues) and outflows (expenses) in the period in which the major economic activity relating to those flows takes place. This seems reasonable since accruals anticipate operating cash inflows or outflows. The recording of accruals results in a more timely recognition of these cash flows.

Note 1: Somewhat cynically, one might suggest that the FASB and accountants
in general are heavily committed to accrual accounting and the resulting construct of net income. Any indication of reduced commitment to net income as a measure of success might seriously undermine the credibility of accrual accounting.

Note 2: The argument made in Section 11.5, namely that there is a “good” side to earnings management if it is used responsibly to reveal inside information about management’s longer-run earnings expectations, is a multi-period extension of this argument. In other words, if accruals smooth out the lumpiness of current period cash flows, then income smoothing (a form of earnings management) can smooth out the lumpiness of current period earnings, to reveal information about longer-run earnings expectations. See Question 9 of Chapter 11 re General Electric.

8. Toni’s utility function is $2\bar{x} - \sigma^2$, where $\bar{x}$ and $\sigma^2$ are the mean and variance of the rate of return of her portfolio, respectively. Toni can borrow an unlimited amount at 4% to invest in the market portfolio. Then, the expected return on her portfolio is:

$$
\bar{x} = \frac{200 \times 1.085 + 1.085z - 1.04z - 200}{200}
$$

$$
= \frac{17 + 0.045z}{200}
$$

where $200$ is the amount of her own investment, $z$ is the amount borrowed, and $0.085$ is the expected return on the market portfolio.

From Section 3.6, Toni has a 0.80 probability that the market portfolio will increase by 10%, giving a return of:

$$
\frac{0.10 \times 200 + 0.06z}{200} = \frac{20 + 0.06z}{200}
$$
She has a 0.20 probability that the market portfolio will increase by 2 1/2%, giving a return of:

\[
\frac{0.025 \times 200 - 0.015z}{200} = \frac{5 - 0.015z}{200}
\]

Then, the variance of Toni's return is:

\[
\sigma^2 = \left[ \frac{20 + 0.06z}{200} - \frac{17 + 0.045z}{200} \right]^2 \times 0.80 + \left[ \frac{5 - 0.015z}{200} - \frac{17 + 0.045z}{200} \right]^2 \times 0.20
\]

which reduces to

\[
\frac{1}{40,000} (36 + 0.36z + 0.0009z^2)
\]

Toni's utility, as a function of z, is thus

\[
U_i(z) = 2\bar{x} - \sigma^2 = \frac{2(17 + 0.045z)}{200} - \frac{1}{40,000} (36 + 0.36z + 0.0009z^2)
\]

Then, the sufficient condition for maximum utility is

\[
\frac{dU_i(z)}{dz} = 0.00045 - \frac{0.36}{40,000} - \frac{0.0018z}{40,000} = 0
\]

which gives \( z = \$9,800 \)

The utility of this investment is

\[
U_i(9,800) = \frac{2(17 + 0.045 \times 9,800)}{200} - \frac{1}{40,000} [36 + 0.36 \times 9,800 + 0.0009 \times (9,800)^2]
\]

\[
= 4.58 - 2.25
\]

\[
= 2.33
\]
9. Off-main diagonal probabilities of an information system are non-zero when conditions are not ideal. Specifically, low earnings quality, that is, low relevance and/or low reliability will increase these probabilities, resulting in less informativeness or, equivalently, greater noise or less transparency in the system. This simply reflects the fact that when conditions are not ideal, the financial statements do not provide perfect information about the true state of the firm.

Lower off-main diagonal probabilities or, equivalently, higher main diagonal probabilities, produce a more informative information system. That is, a given message results in a better ability to discriminate between states of nature as the noise produced by the off-main diagonal probabilities decreases. In the limit, the off-main diagonal probabilities go to zero and the information system becomes perfectly informative (see Question 1).

10. a. The decision-usefulness approach to accounting theory is an approach which deduces the information needs of financial statement users by studying their decision problems.

b. The two questions which arise are:

   i) Who are the users (or constituencies) of financial statements?
   ii) What are their decision problems?

c. According to SFAC 1 of the FASB, the primary constituency of financial statement users is investors.

d. According to the SFAC1’s second objective, investors need information about the amounts, timing and uncertainty of prospective cash receipts from their investments.

e. Investors are assumed to be risk averse. Investment theory tells us that risk-averse investors trade off risk and expected return of securities in making their investment decisions. To do this, they need information about the riskiness of securities.
11. a. Mr. Smart derives the following utilities from the payoffs:

\[ 2\ln(8,000) = 17.97 \]
\[ 2\ln(1,000) = 13.82 \]
\[ 2\ln(5,000) = 17.03 \]
\[ 2\ln(2,000) = 15.20 \]

Based on his prior probabilities, Mr. Smart has the following expected utilities for the two actions:

\[
\begin{align*}
\text{EU (common)} &= (0.50 \times 17.97) + (0.50 \times 13.82) = 15.90 \\
\text{EU (mutual fund)} &= (0.50 \times 17.03) + (0.50 \times 15.20) = 16.12
\end{align*}
\]

Thus, to maximize expected utility, Mr. Smart should buy the mutual fund.

b. Let:

- G = good state of the economy
- B = bad state of the economy
- S = evidence obtained from financial statements

Then, by Bayes' theorem, the posterior probability of the good state is:

\[
P(G / S) = \frac{P(G)P(S / G)}{P(G)P(S / G) + P(B)P(S / B)}
\]

\[
= \frac{0.50 \times 0.75}{(0.50 \times 0.75) + (0.50 \times 0.10)} = 0.88
\]

The posterior probability of the bad state is thus:

\[
P(B/S) = 1 - 0.88 = 0.12
\]
Now, the expected utilities for the two actions are:

\[
\begin{align*}
\text{EU (common)} &= (0.88 \times 17.97) + (0.12 \times 13.82) = 17.47 \\
\text{EU (mutual fund)} &= (0.88 \times 17.03) + (0.12 \times 15.20) = 16.81
\end{align*}
\]

Thus, Mr. Smart should change his decision and buy the common shares.

12. a. Denote buying the J Ltd. bonds as \( a_1 \), and the Canada Savings Bonds (CSB) as \( a_2 \). Then

\[
EU(a_1) = 0.05\sqrt{0} + 0.95\sqrt{5,600} = 71.0915
\]

\[
EU(a_2) = \sqrt{5,400} = 73.4847
\]

John should choose \( a_2 \) and buy the CSB.

Note: Payoffs are specified as gross of initial investment since square root utility is not defined for negative payoffs.

b. By Bayes’ theorem, the posterior probability of \( S_1 \) is:

\[
P(S_1 / G) = \frac{P(S_1)P(G / S_1)}{P(S_1)P(G / S_1) + P(S_2)P(G / S_2)}
\]

\[
= \frac{0.05 \times 0.10}{0.05 \times 0.10 + 0.95 \times 0.80} = \frac{0.0050}{0.0050 + 0.7600} = 0.0065
\]

and \( P(S_2 / G) = 1 - 0.0065 = 0.9935 \).
Then,

\[ EU(a_1) = 0.0065 \sqrt{0} + 0.9935 \sqrt{5,600} = 74.3467 \]

\[ EU(a_2) = \sqrt{5,400} = 73.4847 \]

Now, John should buy the J Ltd. bonds. The good news in the financial statements has lowered John’s subjective probability that J Ltd. will go bankrupt. As a result, a decision to buy the bonds now yields greater expected utility than buying the CSBs.

13. The choice depends on the correlation of returns between A and B share returns. If their returns are perfectly correlated, then the investor is indifferent between the investments described in a and b because, in this situation, diversification will not reduce risk. In effect, the two securities are the same. However, if the correlation is less than perfect, diversification will reduce risk and alternative b will be preferred.

14. a. You should agree. It is possible to reduce risk by diversification because, when more than one risky asset is held and returns on these assets are not perfectly correlated, firm-specific risks tend to cancel out. If one share should realize a low return, there is always the chance that another share in the portfolio realizes a high return. This reduces the variance of the return on the portfolio, hence reducing portfolio risk.

b. Risk cannot be reduced to zero by diversification because economy-wide, or systematic, risk would still remain. Since this risk is common to all securities, it cannot be diversified away. It shows up as the covariance terms in a diversified portfolio. That is, the returns on 2 securities will be correlated when they are both affected by economy-wide factors.
c. Beta, which measures the co-movement of price changes of a security with respect to price changes in the market portfolio, reflects the amount of economy-wide, or systematic, risk contributed by a stock to a portfolio. This is the risk that cannot be diversified away. In contrast, firm-specific risk can be diversified away, even for portfolios consisting of relatively few securities. For this reason, beta is the relevant measure of risk in a diversified portfolio.

15. a. The payoff table for Marie’s decision is:

<table>
<thead>
<tr>
<th>Act</th>
<th>State</th>
<th>Not Bankrupt</th>
<th>Bankrupt</th>
</tr>
</thead>
<tbody>
<tr>
<td>a_1 (buy bonds)</td>
<td>$1,144</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>a_2 (buy CSB)</td>
<td>$1,064</td>
<td>$1,064</td>
<td></td>
</tr>
</tbody>
</table>

Based on her prior probabilities and square root utility function, the expected utility of each act is:

\[ EU(a_1) = 0.6 \times \sqrt{1,144} + 0.4 \times \sqrt{0} \]

\[ = 0.6 \times 33.82 + 0 \]

\[ = 20.29 \]

\[ EU(a_2) = 0.6 \times \sqrt{1,064} + 0.4 \times \sqrt{1,064} \]

\[ = 32.62 \]

Therefore, Marie should take \(a_2\) and buy the CSB.

Note: Payoffs are evaluated gross in this question since negative payoffs are not defined for square root utility.
b. From Bayes' theorem, Marie's posterior probabilities over the states are:

\[ P(NB \mid LO) = \frac{0.6 \times 0.5}{0.6 \times 0.5 + 0.4 \times 0.05} = \frac{0.30}{0.32} = 0.94 \]

\[ P(B \mid LO) = 1.00 - 0.94 = 0.06 \]

The expected utility of each act now is:

\[ EU(a_1 \mid LO) = 0.94 \sqrt{1,144} + 0.06 \sqrt{0} \]

\[ = 0.94 \times 33.82 + 0 \]

\[ = 31.79 \]

\[ EU(a_2 \mid LO) = 0.94 \sqrt{1,064} + 0.06 \sqrt{1,064} \]

\[ = 32.62, \text{ as before.} \]

Therefore, while the expected utility of \( a_1 \) has increased substantially, Marie should still take \( a_2 \).

Note: The reason the decision does not change is the low probability of the message LO conditional on the NB state (0.50). This suggests that the present pay-as-you-go accounting for debt (specifically, pensions and other post-retirement benefits) is low in relevance—given that Risky is not headed for bankruptcy, the omission of substantial liabilities from the balance sheet does not predict the NB state very well. This leads to part c.

c. The new standard will increase the relevance of Risky's financial statements, since the present value of future employee benefits is now shown on the balance sheet, and net income reflects the change in this present value. This raises the main diagonal information system probabilities. However, the expected, discounted calculations will require numerous estimates. This reduces reliability, thereby lowering the main diagonal probabilities.
The net impact on the main diagonal probabilities depends on which effect predominates. Given that the probability of LO conditional on state NB is quite low before the standard, it seems reasonable that the net effect would be to increase this probability. Presumably, the Standards board also feels that the relevance effect is the stronger or it would not have adopted the standard. Thus, the most likely impact is that the main diagonal probabilities will increase.

Note: It may be worthwhile to point out that if the main diagonal probabilities increased even slightly under the new standard, this could be enough to change Marie’s decision in b to \( a_1 \). If enough investors reacted this way, the increased demand for Risky’s bonds would lower the firm’s cost of borrowing.

16. a.

\[
EU(a_1) = 0.2\sqrt{324} + 0.8\sqrt{0} \\
= 0.2 \times 18 + 0 \\
= 3.6
\]

\[
EU(a_2) = 0.2\sqrt{36} + 0.8\sqrt{36} \\
= 6
\]

The investor should take \( a_2 \).

b. By Bayes theorem:

\[
P(H \mid G) = \frac{P(H)P(G \mid H)}{P(H)P(G \mid H) + P(L)P(G \mid L)} \\
= \frac{0.2 \times 0.6}{0.2 \times 0.6 + 0.8 \times 0.1} \\
= .12 \\
= .12 + .08 \\
= .20 \\
= 0.6
\]

Thus \( P(L \mid G) = 1 - 0.6 = 0.4 \)
Then,

\[ EU(a_1) = 0.6 \sqrt{324} + 0.4 \sqrt{0} \]
\[ = 0.6 \times 18 + 0 \]
\[ = 10.8 \]

\[ EU(a_2) = \sqrt{36} \]
\[ = 6 \]

The investor should now take \( a_1 \).
The impact on the information system of requiring fair value accounting is:

- Increased relevance. The information system shows the probabilistic relationship between current financial statement information and future firm performance. By requiring fair value accounting, the relationship between current financial statement information and future firm performance is improved, since current values are the best predictors of future values. This increases the main diagonal probabilities of the information system.

- If market prices on well-working markets are available for the fair-valued assets, reliability should not decrease, and may even increase. However, if market values are not available, the possibility of error and manager bias reduces reliability. The main diagonal probabilities will stay the same, increase, or decrease accordingly.

The net effect on the quality of the information system depends on the relative magnitude of these 2 effects. However, it is unlikely that the accounting standard setter would implement the new standard unless it felt the result would be an improvement in financial reporting. Hence the net effect is likely to be an increase in MD&A quality.

Note: Both relevance and reliability effects should be mentioned. However a conclusion that the net effect will increase MD&A quality is not necessary, provided there is some recognition that the 2 effects may work in opposite directions.
17.  

a. 

\[ EU(a_1) = 0.5\sqrt{1089} + 0.5\sqrt{0} \]
\[ = 0.5 \times 33 \]
\[ = 16.5 \]

\[ EU(a_2) = 0.5\sqrt{324} + 0.5\sqrt{196} \]
\[ = 0.5 \times 18 + 0.5 \times 14 \]
\[ = 9 + 7 \]
\[ = 16 \]

Ajay should take \( a_1 \) and invest in AB Ltd.

b. From Bayes' theorem, Ajay's posterior probability of high performance for XY Ltd. is:

\[
P(High | GN) = \frac{P(High)P(GN | High)}{P(High)P(GN | High) + P(Low)P(GN | Low)}
\]
\[ = \frac{0.5 \times 0.6}{0.5 \times 0.6 + 0.5 \times 0.5} \]
\[ = \frac{0.30}{0.30 + 0.25} \]
\[ = \frac{0.30}{0.55} \]
\[ = 0.55 \]

Then, \( P(Low | GN) = 1 - 0.55 = 0.45 \)

\[ EU(a_2) = 0.55\sqrt{324} + 0.45\sqrt{196} \]
\[ = 0.55 \times 18 + 0.45 \times 14 \]
\[ = 9.9 + 6.3 \]
\[ = 16.2 \]

\( EU(a_1) = 16.5 \), unchanged from a.

Ajay should still take \( a_1 \).
c. Based on the new information system, Ajay’s posterior probability of high performance for XY Ltd. is

\[
P(\text{High} | \text{GN}) = \frac{0.5 \times 0.8}{0.5 \times 0.8 + 0.5 \times 0.2} = \frac{0.4}{0.4 + 0.1} = \frac{0.4}{0.5} = 0.8
\]

Then, \(P(\text{Low} | \text{GN}) = 1 - 0.8 = 0.2\)

From which

\[
\text{EU}(a_1) = 16.5, \text{ unchanged from a.}
\]

\[
\text{EU}(a_2) = 0.8\sqrt{324} + 0.2\sqrt{196} = 0.8 \times 18 + 0.2 \times 14 = 14.4 + 2.8 = 17.2
\]

Ajay should now take \(a_2\) and invest in XY Ltd.
18. a. Your prior probabilities include all information you have up to just prior to analyzing the CG Ltd. financial statements. They could include information based on an analysis of CG's past financial statements, plus other news to date about the company from media, websites, speeches by company officials, analyst forecasts, etc. They could also include the results of a study of the current market price of CG shares. If share price is low, this would indicate an unfavourable market evaluation future prospects, and vice versa.

These probabilities are subjective, since they must be assessed by the decision maker.

b. The information system probabilities are objective. They are determined by the informativeness (i.e., quality) of current GAAP.

c. By Bayes' theorem, the posterior probability of the high state, based on GN in earnings, is:

\[
P(\text{High} \mid GN) = \frac{P(\text{High})P(GN \mid \text{High})}{P(GN \mid \text{High})P(\text{High}) + P(GN \mid \text{Low})P(\text{Low})}
\]

\[
= \frac{0.7 \times 0.8}{0.8 \times 0.7 + 0.1 \times 0.3} = \frac{0.56}{0.56 + 0.03} = \frac{56}{59}
\]

\[= 0.95\]

\[
P(\text{Low} \mid GN) = (1 - 0.95) = 0.05
\]

Then:

\[
EU(a_1) = 0.95 \times \sqrt{100} + 0.05 \times \sqrt{36}
\]

\[= 0.95 \times 10 + 0.05 \times 6
\]

\[= 9.5 + .3 = 9.8
\]

\[
EU(a_2) = \sqrt{81} = 9
\]

The decision is to hold.
19. Let the two states of nature be:

   D    You have the disease
   ND   You do not have the disease

Let the messages you may receive be:

   P    Test results positive
   N    Test results negative

The information system is:

<table>
<thead>
<tr>
<th>Message</th>
<th>P</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>ND</td>
<td>.05</td>
<td>.95</td>
</tr>
</tbody>
</table>

Since one person per thousand in the population has the disease, your prior probabilities are:

   Pr( D) = .001
   Pr( ND) = .999

Your posterior probability of D, by Bayes’ theorem, is:

   \[
   Pr(D / P) = \frac{0.001 \times 1}{0.001 \times 1 + 0.999 \times 0.05} = .0196
   \]

Thus your posterior probability is slightly under 2%. According to "The Economist", most people answer this question with 95%. The point should be clear—
probability judgements can be substantially improved by formal use of Bayes’ theorem.

It should be noted that random selection for the test is crucial here. If you self selected yourself for the test because you displayed some of the symptoms of the disease, your prior probability of the disease would be higher than the base rate for the population as a whole of 1 in 1,000. Hence your posterior probability would be higher than 2%. Nevertheless, Bayes’ theorem would still be useful in processing your test results.
Additional Problems

3A-1. A problem that complicates the relationship between current reported earnings and future earning power is when to recognize revenue as earned. Section 1000.47 of the CICA Handbook states that revenue is usually recognized when the vendor has performed its obligations and there is reasonable assurance of the amount and collectability of the sales consideration. IAS 18 states that revenue should be recognized when significant risks and rewards of ownership are transferred to the buyer, the seller has lost effective control, and the consideration that will be received can be reliably measured.

For many firms, the point of sale is regarded as the point in the operating cycle at which these criteria are met. Under some conditions, however, it is debatable if the point of sale does satisfy these criteria. If it does not, this can reduce the ability of the information system to capture the relationship between current and future performance. Greater relevance from recognizing revenue early in the operating cycle will increase the main diagonal probabilities of the information system. However, if revenue is recognized too early, problems of reliability will decrease them even more.

A case in point is Nortel Networks Corporation. In its 2000 annual report, Nortel stated:

The competitive environment in which we operate requires that we, and many of our principal competitors, provide significant amounts of medium-term and long-term customer financing….At December 31, 2000, we had entered into certain financing agreements of…up to $4,100 (millions of U.S. dollars), not all of which is expected to be drawn upon….We may be required to hold certain customer financing obligations for longer periods prior to placement with third party lenders, due to recent economic uncertainty… and reduced demand for financings in capital and bank markets….As well, certain competitive local exchange carriers have experienced financial difficulties….we have various programs in place to monitor and mitigate customer credit risk. However, there can be no assurance that such measures will reduce or eliminate our exposure to customer credit risk.
Any unexpected developments in our customer financing arrangements could have a material adverse effect on our business, results of operations, and financial condition.

Despite these reservations, Nortel included sales under extended-term customer financing in current revenue. Note 1 (c) to its 2000 financial statements stated, in part:

Nortel Networks provides extended payment terms on certain software contracts....The fees on these contracts are considered fixed or determinable based on Nortel Networks’ standard business practice of using these types of contracts as well as Nortel Networks’ history of successfully collecting under the original payment terms without making concessions.

Required

a. Discuss the extent to which Nortel’s revenue recognition policy on contracts for which extended-term customer financing is provided meet the revenue recognition criteria of CICA Handbook.

b. Which revenue recognition policy—Nortel’s policy, or a policy of recognizing revenue only as payments are received under extended-term customer financing contracts—results in the highest main diagonal probabilities of the information system? In your answer, consider both the relevance and reliability of the information.

c. On April 11, 2001, The Globe and Mail reported that Savis Communications Corp. is in default on a $235 million (U.S.) extended term loan facility advanced by Nortel. What does this suggest about the relevance and reliability of Nortel’s revenue recognition policy?

3A-2. The owner of a building approaches a banker for a loan to improve the property, to be secured by the rental proceeds. After reviewing the application, the banker
assesses that, if the loan is granted, there is a 70% probability the rental proceeds will be $100 and a 30% probability the rental proceeds will be $30.

**Required**

a. Assume that the banker is risk neutral. How much would the banker be willing to lend on the security of the rental proceeds?

b. If the banker is risk averse, explain why he/she would only be willing to lend a lesser amount than in part a.

c. Now assume that if the rent is only $30, the banker assesses a 90% probability that the building owner will be “bailed out” by the government, in which case the rent would be restored to $100. How much would the risk neutral banker be willing to lend now? If every banker felt this way, what implications do you see for the banking system and the economy?
3A-3. The following problem was contained in the first edition of the text. It is repeated here for instructors who may wish to pursue a bit more depth in portfolio theory.

a. Consider the common stock of A Ltd., which is currently trading at $40 per share. In the future, there is a 40% chance that the price of A Ltd. will rise to $80 per share and a 60% chance that it will fall to $35.

The stock of B Ltd. is currently trading at $20 per share. In the future, there is a 60% chance the stock price of B Ltd. will rise to $30 and a 40% chance it will rise to $21.25.

Assume that the returns of A Ltd. and B Ltd. are independent (i.e., uncorrelated). As an investor with $800 to invest, would you prefer a portfolio of 20 shares of A Ltd., or a second portfolio consisting of 10 shares of A Ltd. and 20 shares of B Ltd.? Give reasons for your choice, and show any calculations used to support your answer. Carry any calculations to four decimal places.

b. Consider the common stock of D Ltd., which is currently trading at $92 per share.

In the future, there is a 50% chance the value of D Ltd. will rise to $100 per share and a 50% chance it will fall to $90 per share.

The stock of M Ltd. is currently trading at $23 per share. In the future, there is a 50% chance the value of M Ltd. will rise to $25 per share and a 50% chance it will fall to $22.50 per share.

M Ltd. and D Ltd. are both in the same industry and are located side-by-side. As a result, their stocks rise and fall in price together. In other words, the returns on D and M are perfectly correlated. You are an investor with $1,840 to invest. Would you prefer a portfolio of 10 shares of D Ltd. and 40 shares of M Ltd. or one of 20 shares of D Ltd.? Give reasons for your choice. (Hint: You should be able to answer without calculations.)
c. Consider the common stock of X Printers, a textbook manufacturing firm, which is currently trading at $100 per share. Financial analysts estimate that there is a 50% chance the stock price of X Printers will rise to $150 per share in the next period and a 50% chance that it will fall to $80.

Another textbook manufacturing stock currently trading is that of Y Printing, which also trades at $100 per share. Analysts estimate that there is a 50% chance that Y's stock price will rise to $130 per share in the next period and a 50% chance that it will fall to $90.

Now consider a portfolio of 10 shares of X Printers and 10 shares of Y Printing. Because both firms are in the same industry, they are both strongly affected by certain market-wide factors. Accordingly, there is a 40% chance that both stock prices will rise simultaneously, a 40% chance that both will fall, a 10% chance that X's price will rise while Y's price falls and a 10% chance of the opposite occurring.

As an investor with $2,000 to invest, would you prefer the above portfolio (Portfolio XY) or one with 20 shares of X Printers (Portfolio X)? Give reasons for your choice. Show calculations where required and carry to four decimal places.

d. How would financial statement information be useful to investors in revising their prior probabilities that share prices will rise or fall? Explain.
Suggested Solutions to Additional Problems

3A-1. a. Points to consider

- It does appear that Nortel has made a sale when it extends financing to customers, since a contract exists. Nortel claims that the fees on these contracts are fixed and determinable, supporting the Handbook criterion that there be reasonable assurance of the amount of the sales consideration.

- Has Nortel performed its obligations? If the contract includes extended-term vendor financing, Nortel has an obligation to provide this financing. Thus the answer appears to be no.

- Is there reasonable assurance of collectability? Again, the answer appears to be no. Nortel itself provides a warning that its past success in collecting under extended-term financing may not continue, due to current economic uncertainty.

b. It is important to realize that early revenue recognition increases relevance. This increases the main diagonal probabilities of the information system. However, the decrease in reliability that accompanies early recognition decreases these probabilities. Nortel’s policy is characterized by high relevance but low reliability. A policy of recognizing revenue as extended-term contract payments are received features high reliability but low relevance. Given the current economic uncertainty that Nortel mentioned, it seems that the cash basis provides the highest main diagonal information system probabilities.

c. This default is consistent with the conclusion in b. Recognizing revenue when the sale to Savis is on the basis of an extended term loan is relevant because at the time of the transaction, Nortel must have felt that the loans would be ultimately repaid (otherwise, why enter into the transaction?). Consequently, recognition gives investors information about
future cash flows. However, reliability is low due to credit risk, as Nortel points out in its annual report.

3A-2. a. Since the loan is secured by the rental proceeds, the banker will receive back either $30 or $100. The expected value of this loan given a risk neutral banker, is:

\[
EV = 0.7 \times 100 + 0.3 \times 30
\]

\[
= 70 + 9
\]

\[
= 79.
\]

Thus the risk neutral banker will be willing to lend $79 on the security of the rental proceeds.

Note: In decision theory, the $79 is an example of a certainty equivalent. The decision maker is indifferent between a risky gamble of ($100, $30) with probabilities of 0.7 and 0.3, respectively, and $79 with certainty.

b. If the banker is risk averse, he/she will only be willing to loan less than $79. This is because, for a rational, risk averse decision maker, the expected utility of a risky investment is less than the utility of its expected monetary value (this can be seen from Figure 3.3 of the text). The banker will lower the amount loaned to the point where the utility of the amount loaned is equal to the expected utility of the risky gamble.

Note: In other words, the certainty equivalent of a given, risky gamble is lower for a risk averse decision maker than for a risk neutral one.

To illustrate, suppose that the banker has square root utility. The expected utility of the gamble is:
Whereas the utility of the expected value of the loan is

$$U(79) = \sqrt{79} = 8.89$$

Thus the risk averse banker’s expected utility of the loan (8.64) is less than the utility of the expected value of the loan (8.89). Thus, the banker will only loan an amount x such that:

$$U(x) = \sqrt{x} = 8.64$$

This yields $$x = $74.65$$ as the maximum loan. The certainty equivalent of the risky loan is reduced to $74.65 from $79 because of risk aversion here.

c. Because of the probable government bailout, the risky loan is now characterized by rental proceeds of $100 with probability 0.9 and $30 with probability 0.1. The risk neutral banker’s expected value (i.e., certainty equivalent) of the loan is now:

$$EV = 0.9 \times 100 + 0.1 \times 30$$

$$= 90 + 3$$

$$= 93$$

The banker is now willing to lend up to $93.

An implication for the banking system is that bankers are more willing to lend when there is a possibility of government bailout. Indeed, they may not bother to evaluate the intrinsic value of loan applications very carefully, since, if the loan gets into trouble, they know that the government will probably rescue them. This phenomenon is a version of the moral hazard problem, since bankers are tempted to “shirk” on the effort needed to properly evaluate and monitor loans.
An implication for the economy is that there will be a high level of economic activity, because loans are easy to get. However, there may well be over-investment, with many projects ultimately failing since borrowers have reduced incentive to undertake only high quality projects, and bankers have reduced incentive to monitor loan quality. This situation will continue as long as the government continues its policy of bailing out borrowers and their lenders. However, should it become apparent that the government is unwilling or unable to continue the policy, bankers will stop lending and the economy may collapse.
3A-3. a.

<table>
<thead>
<tr>
<th>Portfolio A</th>
<th>End value</th>
<th>Gross rate</th>
<th>Probability</th>
<th>Expected rate</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>(20 shares of A Ltd.)</td>
<td>1,600</td>
<td>1,600/800 = 2.000</td>
<td>0.40</td>
<td>0.8000</td>
<td>(2.000 - 1.325)^2 \times 0.40 = 0.1823</td>
</tr>
<tr>
<td>700</td>
<td>700/800 = 0.875</td>
<td>0.60</td>
<td>0.5250</td>
<td>(0.875 - 1.325)^2 \times 0.60 = 0.1215</td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td>1.3250</td>
<td>0.3038</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Portfolio AB</th>
<th>End value</th>
<th>Gross rate</th>
<th>Probability</th>
<th>Expected rate</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>(10 shares of A Ltd.)</td>
<td>800 + 600 = 1,400</td>
<td>1,400/800 = 1.7500</td>
<td>0.24</td>
<td>0.4200</td>
<td>(1.7500 -1.325)^2 \times 0.24 = 0.0434</td>
</tr>
<tr>
<td>800 + 425 = 1,225</td>
<td>1,225/800 = 1.5313</td>
<td>0.16</td>
<td>0.2450</td>
<td>(1.5313 -1.325)^2 \times 0.16 = 0.0068</td>
<td></td>
</tr>
<tr>
<td>and 20 shares</td>
<td>350 + 600 = 950</td>
<td>950/800 = 1.1875</td>
<td>0.36</td>
<td>0.4275</td>
<td>(1.1875 -1.325)^2 \times 0.36 = 0.0068</td>
</tr>
<tr>
<td>350 + 425 = 775</td>
<td>775/800 = 0.9688</td>
<td>0.24</td>
<td>0.2325</td>
<td>(0.9688 -1.325)^2 \times 0.24 = 0.0305</td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td>1.3250</td>
<td>0.0875</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Answer is in terms of gross rate of return. Use of net rate of return, by subtracting one from each return, gives similar result.
a. Both portfolios have the same expected return, however, the diversified portfolio has a lower variance (and, accordingly, risk) and is therefore preferable for a risk-averse investor.

Note: A “shortcut” answer to this question is possible. Once it is established that the expected returns on the two portfolios are equal, Portfolio AB is preferred because the returns are not correlated. That is, Portfolio AB must have a lower variance than Portfolio A.

b. Note that the returns of M Ltd. and D Ltd. are equal and perfectly correlated. Thus, the variance of the diversified portfolio is identical to that of the portfolio consisting solely of D Ltd. shares. Diversification in this case does not result in reduced risk through lower variance. Accordingly, both portfolios are equally preferable.
c.

<table>
<thead>
<tr>
<th>Portfolio X</th>
<th>End value</th>
<th>Gross rate of return</th>
<th>Probability</th>
<th>Expected rate of return</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>(20 shares of X Printers)</td>
<td>3,000</td>
<td>3,000/2,000 = 1.50</td>
<td>0.50</td>
<td>0.75</td>
<td>$(1.50 - 1.15)^2 \times 0.50 = 0.0613$</td>
</tr>
<tr>
<td></td>
<td>1,600</td>
<td>1,600/2,000 = 0.80</td>
<td>0.50</td>
<td>0.40</td>
<td>$(0.80 - 1.15)^2 \times 0.50 = 0.0613$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
<td>1.15</td>
<td>0.1226</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Portfolio XY</th>
<th>End Value</th>
<th>Gross rate of ret.</th>
<th>Probability</th>
<th>Expected rate of return</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>(10 shares of X Printers and 10 shares of Y Printing)</td>
<td>1,500 + 1,300 = 2,800</td>
<td>2,800/2,000 = 1.40</td>
<td>0.40</td>
<td>0.560</td>
<td>$(1.40 - 1.125)^2 \times 0.40 = 0.0303$</td>
</tr>
<tr>
<td></td>
<td>800 + 900 = 1,700</td>
<td>1,700/2,000 = 0.85</td>
<td>0.40</td>
<td>0.340</td>
<td>$(0.85 - 1.125)^2 \times 0.40 = 0.0303$</td>
</tr>
<tr>
<td></td>
<td>800 + 1,300 = 2,100</td>
<td>2,100/2,000 = 1.05</td>
<td>0.10</td>
<td>0.105</td>
<td>$(1.05 - 1.125)^2 \times 0.10 = 0.0006$</td>
</tr>
<tr>
<td></td>
<td>1,500 + 900 = 2,400</td>
<td>2,400/2,000 = 1.20</td>
<td>0.10</td>
<td>0.120</td>
<td>$(1.20 - 1.125)^2 \times 0.10 = 0.0006$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
<td>1.125</td>
<td>0.0618</td>
</tr>
</tbody>
</table>

**Note:** Answer is in terms of gross rate of return. Use of net rate of return, by subtracting one from each return, gives similar results.
The diversified portfolio has lower risk but also lower expected return. Consequently, the two portfolios are not comparable. The preferred portfolio will depend on the investor’s personal tradeoff between risk and return. Thus, either portfolio can be selected as preferred.

d. Financial statement information is useful to investors because it provides evidence about the states of nature. That is, the financial statements form an information system which gives the probabilities of the GN or BN in the financial statements conditional on each state. Unless the information system is non-informative about the state of the firm, the GN or BN in the current financial statements enables rational investors to revise their prior state probabilities. For example, good news (e.g., high current earnings) would lead investors to revise upwards their prior probabilities of a high performance state, and vice versa. Investors may then re-evaluate their investment decisions using their revised probabilities.