discount rate should be derived from transaction evidence when the expectation valuation method is used (as it nearly always is). CFK notes that purchasers will often bring their own required earnings rate to bear in the valuation of a forest investment opportunity.

The Capital Asset Pricing Method is also used in evaluating an investment. One would expect transaction evidence to provide the most compelling measure of discount rate but it must be handled with caution where the transaction evidence is limited in amount and frequency – as is the case in forestry as noted above. Transaction evidence is “backwards looking” and will not signal any fundamental shifts in perceptions of forest value that might lie ahead.

Yields

The matter that is currently topical is that of genetic gain. CFK notes that some practitioners explicitly include it in yield projections, whilst others do not go beyond what gain is captured during the course of forest inventory. Knowledge in this area continues to increase, and is not complete at the present time.

What is Valued

It is important to explicitly state what is valued. CFK notes that this is not always the case. Are assets other than the tree crop – such as sealed arterial roads – included in the value?

A Couple of Warnings

The timing convention that is adopted can have a significant impact on the assessed value. Timing convention pertains to the assumed timing of costs and returns in each year of the modelling period. In CFK’s experience, a mid-year convention is commonly adopted. A trap awaits those who simply apply the Microsoft NPV function to a cash flow projection – this function assumes an end-of-year timing. The discrepancy can amount to millions of dollars in the valuation of a large forest.

The rule-of-thumb relationship between pre-tax and post-tax discount rates (“around 2% difference”) breaks down when one is assessing a near-mature forest with a compressed area-age distribution. The purchasers of such a forest will enjoy recouping amortisation losses over a few brief years, with a consequent wide divergence between pre- and post-tax measures.

Forest valuation, capital budgeting and discount rates

Joe Cheung and Alastair Marsden

1.0 Introduction

Valuation of a forest is a complex task. There is limited market based evidence that can be used for value comparisons due to the low number of actual transactions and the heterogeneous nature of forests (see Manley 2001). Valuers often resort to other valuation techniques. A widely used method is the “Expectation Approach” as prescribed in the NZIF Forest Valuation Standards. In essence this approach is based on discounted cash flows (DCF) to arrive at the forest’s net present value (NPV).

In this paper we seek to highlight issues from a financial market perspective where valuers may have greatest disagreement or where the Forest Valuation Standards provide less definitive guidelines. We focus on two aspects of the Expectation Approach – the impact of exchange rate forecasts on log prices and the determination of the cost of capital. We also highlight that the DCF methodology does not recognise the value of flexible harvest strategies.

2.0 Log Price and Exchange Rate Forecasts

Critical to any DCF forest valuation is a forecast of log prices. Log prices are typically denominated in United States Dollars (“USD”). This suggests two possible approaches to undertake any DCF valuation. The first approach is to forecast log prices and costs in New Zealand dollars (“NZD”) and discount at the NZD cost of capital (the “NZD approach”). The second approach is to forecast prices and costs in USD, use a USD discount rate and convert the resulting DCF value to NZD at the current exchange rate (the “USD approach”).

We discuss briefly below potential problems in implementing these two approaches.

2.1 The NZD Approach

According to the latest Manley (2001) survey data, most forest valuers in forecasting future log prices:

- Assume no real increase or decrease in log prices over time; and
- Use current log prices with an adjustment to long-term trend prices or use an average price over some previous quarters.

It is not clear from the Manley survey data whether log price forecasts and long-term price trends are based on prices observed in NZD or in another currency (e.g. USD).

To demonstrate some of the potential problems, assume that prices for logs are stable in USD but fluctuate in NZD due to changes in the exchange rate.\(^1\)

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\(^1\) See Chapter A3 of the Standards.

\(^2\) Empirical evidence in support of this proposition is contained in Market Report, Issue No 5 by the Ministry of Forestry. Based on log prices measured over the period 1986 to 1996, prices in USD terms were more stable than prices denominated in Japanese Yen or NZD (See Figure 7 of Market Report, Issue No. 5).
Furthermore, suppose that New Zealand is a “price-taker”. In this case, a forecast of NZD denominated log prices is inextricably linked to a forecast of the NZD/USD exchange rate. Historical log price trends in NZD will also depend on exchange rate changes over the measured period. A failure to recognise this implicit relationship may lead to erroneous estimates of future log prices in NZD or forecasts that are inconsistent with forecast changes in the NZD/USD exchange rate.

For example, consider a period when the NZD has gradually depreciated against the USD. NZD log prices would have followed an upward trend. If log prices are stable in USD, forecasts of future revenues denominated in NZD based on the upward NZD price trend will be reasonable only if the NZD/USD exchange rate is expected to depreciate further. If the exchange rate is expected to remain the same or revert back to its previous level, revenue forecasts in NZD based on the historical NZD price trend will overstate the forest value. In practice, the problem of making log price projections in NZD is more complex given that USD timber prices are also uncertain. Any NZD price trend can be a product of trends in USD timber prices and the exchange rate. Combinations of the two factors can lead to a wide variance in the range of values.

2.2 The USD Approach

Under the assumptions that log prices are stable in USD and New Zealand is a “price-taker”, the USD approach avoids the need to forecast changes in the NZD/USD exchange rate and the impact these changes might have on NZD log prices and revenues. This minimises possible disagreement amongst different valuers on revenue forecasts. It may also minimise differences in the range of DCF values if the present value of revenues is large relative to the present value of costs. Nevertheless, the valuer still faces the difficult task of forecasting the NZD/USD exchange rate to convert NZD costs to USD.

In summary it is far from clear what is the best approach to capital budgeting. Only where markets are perfect and purchasing power and interest rate parities hold will the two approaches above give identical answers. We believe more research is required on issues such as:

- Are prices for New Zealand timber set in “international” or “domestic” markets and to what extent are New Zealand producers a “price-taker”?
- How do exchange rate fluctuations impact on the NZD price of logs?
- Does purchasing power parity hold in New Zealand and how should the valuer estimate long-term NZD/foreign currency exchange rates?

3.0 Cost of Capital

To determine the discount rate in conducting any DCF analysis, the Forestry Valuation Standards (B10-2) suggest in order of relevance:

- An implied discount rate from asset transaction evidence.
- An implied discount rate derived from the share price of forest companies.
- The minimum market acceptable IRR observed in a range of alternative forest projects.

- Use of the Capital Asset Pricing Model (CAPM) and the Weighted Average Cost of Capital (WACC) approaches.

3.1 An implied discount rate from asset transaction evidence

The absence of a large amount of transactional evidence makes determination of discount rates based on actual market sales difficult. Different forest valuers may estimate different implied discount rates for the same market transaction (see Table 2; Manley 2001). To determine the implied discount rate based on comparable transactional evidence the valuer needs to know the expected cashflows from the forest (e.g. forecast log prices, costs and taxation etc). Also critical to the determination of the implied discount rate would be information of what risks are incorporated into the forecast cashflows and what risks are implicit in the discount rate. In any DCF analysis the types of risk reflected in the cashflows must be consistent with the nature of risks reflected in the discount rate (for a discussion on this point see the Forest Valuation Standards A4-21 and A4-22).

3.2 An implied discount rate derived from the share price of forest companies

A common approach to determine an implied discount rate based on traded share prices is to adopt a dividend discount model (see Pratt 1998). Based on the current share price and forecasts of future dividends the implied discount rate equates the present value of future expected dividends to the current share price.6

To determine the implied cost of capital one must first estimate the future dividends of the company. Any bias in this estimate will bias the estimate of the implied cost of capital.

Analysis undertaken by the authors adopting this approach suggests the discount rate required by investors in the sharemarket is higher (by 2% or more) than the discount rate assumed by the independent forest valuers. However, one must again be cautious in drawing strong conclusions as to any implied discount rate determined under this method.

Alternative explanations for the discount include lower log price assumptions used by market investors or other frictions (e.g., the share market is inefficient, the traded share price reflects a price for a “minority” parcel of shares only, the company has entrenched management etc).

6 However, there is much international evidence that purchasing power parity does not hold (e.g., Rogoff 1996). In addition, there is a large body of evidence that the current spot rate adjusted for interest rate differentials between two currencies (i.e. the forward exchange rate) is a biased estimate of the future spot rate (e.g., MacDonald 1991).

4 We ignore in the discussion that follows determination of the discount rate based on “Declared asset reporting rates”. Under the Forest Valuation Standards B10-2 this is the least relevant source of information.

5 An alternative approach is to use a discounted residual income model where the implied cost of capital equates the current stock price to the present value of expected future cashflows to shareholders (Gebhardt et al 2001).
3.3 The minimum market acceptable IRR observed in a range of alternative forest projects

Similar to the determination of an implied discount rate based on transactional evidence, it is necessary to have a sufficient number of market observations to ascertain the minimum IRR for alternative forest projects. In determining the minimum IRR based on market evidence, the types of risks embedded in the cashflows and the discount rate must also be known to enable meaningful conclusions.

3.4 Use of the Capital Asset Pricing Model (CAPM) and the Weighted Average Cost of Capital (WACC)

The CAPM is a theoretical model developed by Sharpe (1964) and Lintner (1965) that posits beta or the systematic risk of an asset is the only factor relevant to the pricing of a risky asset. Early empirical evidence (e.g., Fama & Macbeth 1973) provided support for the CAPM. However, more recent evidence in the United States (e.g., Fama & French 1992) and in New Zealand (e.g., Bryant & Eleswarapu 1997) suggests that beta has poor explanatory power in explaining returns to risky assets and that firm size and the ratio of the book (accounting) value of equity to the sharemarket capitalisation of equity are better risk proxies in explaining asset returns.

Notwithstanding the above, the CAPM remains a widely accepted model used in practice by academics and practitioners alike. First, there still exists much controversy over the Fama-French results (e.g., Black 1993; Roll & Ross 1994). Second, other theoretical asset pricing models such as the Arbitrage Pricing Theory are difficult to apply in practice.

It is standard practice of most forest values to assume a domestic CAPM. Under a domestic CAPM the New Zealand market is assumed to be segregated (i.e., New Zealand domestic investors are the only investors in the market and capital does not flow in or out of New Zealand). All returns are measured in NZD and the New Zealand market index is the appropriate index to use to measure and determine an asset or equity beta.

In adopting a domestic CAPM many practitioners also use a tax-adjusted version of the CAPM under New Zealand’s dividend imputation system (see Cliffe & Marsden 1992; Lally 1992). A simplified form of the model is:

\[
R_t = R(1 \cdot 0.33) + \beta'(PTMMP)
\]

where: \( R_t \) = cost of equity capital after corporate tax, \( R \) = risk free rate, \( PTMMP \) = post tax market risk premium, \( \beta' \) = levered or geared beta.

If the company is unlevered (i.e., has no debt) the equity beta equals the asset beta. Estimating a forestry beta in the New Zealand market is invariably problematic. This is given the small number of available empirical measures of betas using share price data of New Zealand listed forestry companies. In practice this means that one must often rely on offshore proxies of beta estimates of forest companies and also detailed consideration of the fundamental factors (e.g., sensitivity of product demand to GNP changes, interest rates changes etc) that impact on beta.

If one adopts the forest Valuation Standards (A4-12) and uses an asset or unlevered equity beta estimate in the range of 0.50 to 0.80\(^{6} \cdot \) a PTMMP\(^{6} \) of 8%, a risk free rate of 6.5% and the inflation rate of 1.5%, the real unlevered cost of equity is between 6.73% and 9.12%. Under the dividend imputation tax system in New Zealand it can be shown this real unlevered cost of equity will be close to the real WACC.\(^{9} 
\)

This cost of capital estimate (6.73% to 9.12%) compares to the Manley (2001) survey data of a discount rate applied to post corporate tax cashflows of between 7.5% and 9.5%.

In summary there are considerable practical difficulties in applying all the approaches contained in the Forest Valuation Standards to determine the cost of capital. The lack of direct transactional evidence means the valuer should consider all methods to determine the discount rate. At this stage it is not clear that one approach is necessarily more superior or relevant than any other approach.

Further empirical research on the implied cost of capital using both domestic and international transactional data (with an appropriate recognition of the types of risks inherent in the expected cashflows) is required. More research is also warranted on different asset pricing models (including the CAPM) to better assess the comparative merits of each approach.

4.0 What does the DCF Ignore?

The DCF methodology is a ‘static’ valuation approach. It does not accommodate a ‘dynamic’ harvest strategy whereby harvesting is dependent on the evolution of log prices.

To illustrate a simple dynamic harvest strategy, consider a ‘marginal’ forest where the harvest cost (say, at $90/unit) exceeds the harvest revenue when log prices

\(^{6} \) Under a domestic CAPM it is assumed that the New Zealand market is segregated (i.e. capital does not flow in or out of New Zealand). However, for assets that are internationally traded in highly integrated world markets, the use of an international CAPM may be more appropriate. Under an international CAPM, beta is measured against a world market index. Potentially there could be a significant difference between the costs of capital derived under the two versions of CAPM. The differences arise primarily from differences in the estimation of beta and the market risk premium.

\(^{7} \) This compares to estimates of the average asset beta for the NZ market of approximately 0.7 to 0.8.

\(^{8} \) Common estimates of the PTMMP in New Zealand are currently between 7.5% and 8.5%. However, there is currently considerable debate in the academic literature and among practitioners on the level of the market risk premium. The market risk premium can also vary over time with the level of short-term interest rates and market volatility. Estimates of the standard pre-tax market risk premium (equal to \( R_t - g \)) in Anglo-Saxon markets and based on historical time series data range between circa 4.5% and 11% (see DIsson et al 2000). Chay et al (1995) estimate the MRP at 6.49% for New Zealand between 1931 – 1994. However, several academics now argue for lower ex-ante estimates of the market risk premium (see Welch 2001).

\(^{9} \) The assumption of a domestic CAPM still applies.

\(^{10} \) This simplifying assumption implies that no discounting is necessary since under any assumed harvest time n, the present value of net cash flow is: (log price-cost) * (1+n)-(1+r) = log price-cost. This assumption is obviously unrealistic but it does illustrate why a dynamic harvest strategy adds value to the forest.
are low. Suppose log prices in each period are independent and they are either high (say, at $140/unit) or low (say, at $60/unit) with equal probability. For simplicity, assume that within the allowable harvest timeframe, the tree grows at a constant rate of r per period that equals the discount rate\(^1\). Under these assumptions, there is only one future cash flow (at harvest) and its present value is given by the difference between the log price and harvest cost.

Under DCF, the present value per unit (under any harvest assumption) is simply the expected price less harvest cost, or \((0.5 \times 140 + 0.5 \times 60) - 90 = 50\) $\). Alternatively, the present value per unit can be written as the expected profit, or \((0.5 \times 140 - 90) + 0.5 \times (60 - 90) = 10\). However, a practical harvesting strategy in this case is most likely to be dynamic. If the log price is low, harvesting will be delayed to avoid a loss. If the log price is high, the log will be harvested. Therefore, under this simple dynamic strategy, the present value per unit is approximately \$140-\$90 = \$50\).

The marginal forest in our hypothetical example above is worth substantially more under a dynamic harvest strategy than under a static harvest strategy that is implicitly assumed under the DCF. A price-dependent harvest strategy could also add value even when log prices are unlikely to fall below harvest costs. This happens if log prices follow some commodity price cycles. In this case logs may be harvested at prices above the average price that will be assumed under the DCF approach\(^1\).

5.0 Conclusion

Valuation under a DCF methodology has strong theoretical foundations. However, in applying the methodology valuers may have wide differences of opinion on the forecast cash flows and the discount rate.

It is common among New Zealand forest valuers to forecast log prices based on trends in the NZD price and use a NZD discount rate. A better approach may, however, be to discount forecast cash flows in USD (or another foreign currency) and then convert the NPV at the spot exchange rate. More research is required into how log prices vary in response to changes in the NZD exchange rate.

We also highlight some of the practical difficulties in the determination of the discount rate. Finally we briefly discuss shortfalls in DCF analysis. A DCF value may significantly understate the value of a forest if the owner possesses the flexibility to delay or advance harvest depending on how log prices evolve over time.

Acknowledgements

The authors acknowledge helpful discussions with Bill Liley, Phil Hollinshead, Simon Papps and Simon Walker of Jaako Pöyry Management Consulting (Asia-Pacific) Ltd and comments from Bruce Manley. However the opinions expressed in this paper are the authors’ alone.

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\(^1\) Given any finite allowable n-period harvest timeframe in which the growth rate equals the discount rate as assumed, we need to calculate the probability (p) that the log price remains low in all n periods in order to work out the exact expected profit. For example, if n = 5, p = 0.5, \(0.03125\), present value = \$0.96875\times (\$140-\$90) + 0.03125\times (\$60-\$90) = \$47.5\). The present value gets closer to \$50 as n gets larger since the probability of harvesting at the high log price before the last allowable period gets closer to 1.

\(^2\) For instance, if troughs and peaks of log price cycles are roughly symmetric, the average price will be used as to calculate expected cash flows under DCF. However, the realised prices are likely to be above the average price since harvesting will be delayed during a trough and advanced during a peak under a dynamic harvest strategy. See Brennan and Schwartz (1985) for details on the value of a dynamic harvest strategy.