ARTICLE

Quantifying the effects of changing log prices on land values for forest valuations

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Abstract

In forestry valuations determined using a discounted cashflow approach real costs are normally assumed to remain constant because real changes in costs are either unpredictable or not easily quantifiable. It is postulated in this report that an estimate of real forest land value change stemming from increased log price is predictable and should be incorporated in forest valuations if real log price escalations are to be used.

The methodology presented here for deriving land value changes is based on the hypothesis that since long-term real increase in log prices will result in higher land expectation values it is inevitable that the market (land owners) will perceive the change in profitability and will eventually transfer, in part, into higher land rentals. This in turn will have a negative feedback effect on the forest valuation.

It is noted that land rentals may not represent a large proportion of total forestry costs on a per hectare basis, but a slight increase in the rental compounded over the forest rotation represents a significant reduction in the profit margin. So in situations where the ownership of vast areas of forests is being separated from the land and log or timber product prices are expected to increase significantly, it is considered appropriate to account for this element in forest valuations.

Introduction

Forest valuations are frequently determined using a discounted cashflow analysis procedure. Inherent to this approach is the assumption that real costs remain constant over time, while real log price increases (over a finite period or in perpetuity) are often incorporated in forest valuations.

It is recognised that costs do in fact change in real terms over time due to factors including:

(a) economic environment changes (e.g. taxation policy, exchange rate, cost of labour, capital and land);
(b) changes in the biological flora and fauna (i.e. weeds, entomological, pathological and mammal pest changes) which necessitate the incorporation, or removal, of preventative and control measures;
(c) physical environmental changes (e.g. effect of increased CO_2 and associated climatic changes which will affect (i) the growth rate and the rotation length, and (ii) the changes in the distribution, nature, and severity of weeds and pests which will affect forestry practices as in (b));
(d) management and operational efficiency changes (productivity changes);
(e) silvicultural practice changes; and
(f) technological changes (e.g. harvesting machinery or transport changes).

The assumption that costs will remain constant is an accepted practice because these factors are either not easily quantified or are obviously unpredictable. In this paper it is postulated that an estimate of the change in real land prices is predictable and could be incorporated in forest valuations. This paper provides an approach to estimating real land price changes, followed by a brief note on the application of derived real land price changes, and how to quantify the impact of real land price changes on forest valuations.

The Relationship Between Land Prices and Forest Profitability

Relative prices of land used for growing forests should reflect the relative profitabilities of the forest crop, because land value is largely a reflection of the productive potential use of that land. An accessible fertile and level site located in close proximity to a market will obviously command a higher market price than a remote, degraded and inaccessible site of equal size on broken and steep terrain, because any land use on the former site will be more productive and the products will be less expensive to supply to markets. This relationship may be less evident on some sites because the land use is not always the most productive use of the site. Reasons for this include companies requiring sources to be of a minimum economic size in a contiguous block, so the ideal use/suitability relationship cannot always be attained in practice. The opportunity cost of practising a land use which is not the most productive may be more than compensated for by economies of scale achieved. Historical factors have also led to a certain land use being practised when that land could now be more productive under an alternative use. Further discussion and concepts on the determination of land prices or rent, ranging from those presented by original nineteenth century founders such as Thomas Robert Malthus, David Ricardo and Johann Heinrich von Thunen, through to present day pricing mechanisms and determinants, are outlined by Barlowe (1978).

Over time land price changes have a positive correlation with changes in land use profitabilities. However, the land value lags behind changes in land use profitabilities because of the time it takes for price signals to feed back and the time between land valuation reviews. So, as the profitability of plantation forestry changes, perception of the land value should change, which will result in changing the land prices. The following case illustrates this point.

If it is accepted that the real value of log prices do increase at a projected rate of, say, 1.5% p.a. over the next 30 years, resulting in newly planted forest almost doubling in value over this period, then the landowners would come to recognise the forest profitability changes. The increasing profitability would become evident earlier as areas of previously established forest will mature in the interim period. If the true unimproved land value does increase in real terms over the forest rotation this should result in land rentals (actual, or imputed if the land is owned by the forest grower) increasing significantly. If the land rental is reviewed periodically the total forest growing costs may be markedly affected. Therefore, the actual profitability of growing the crop, and hence the forest value, may be considerably less than originally anticipated.

The following analysis shows a way to quantify the effects of changing log prices on land values for forest valuations. There are three stages in this analysis. Initially a means of calculating a Land Expectation Values (LEV) curve which incorporates predicted escalating log prices is presented. An approach to deriving land price predictions using the LEV curve as a baseline is then outlined. True forest values can then be determined using the derived changing land prices.

STEP 1: Derivation of land expectation values curve

The Land Expectation Value (LEV) is an accepted forest management method used for calculating how much a tract of land is worth to the forest grower. The LEV of a site represents the true (affordable) value of the land to the forest grower which may be at variance to the perceived (or market) value. Fraser (1986) states: "On no account should the LEV be interpreted as the price to be paid for land; it is no more than a yardstick for judging market value. In the final analysis the going market value is the main criterion in assessing a price." In this analysis the LEV is used as the base line to derive future land prices for the true valuation of existing forest crops on land predominantly suited to forestry.

The LEV is defined as:

$$L_e = V \times \frac{(1.0+i)^n}{(1.0+i)^n - 1.0} \qquad \text{(Equation 1)}$$

Where:

L_e = the land expectation value
V = the present value of a perpetual periodic net income that will be received every n years
n = the number of years between periodic net income payments
i = the interest rate

Fundamental assumptions in this equation are:

(a) the land value is zero in the calculation of the present value V
(b) the land has no residual stand (i.e. bare land at start)
(c) the land will be forested in perpetuity
(d) the cashflows from the forest will be the same in perpetuity (Leuschner, 1984)

To determine the land price for each year of the planning horizon the LEV should be calculated separately for each year. For instance, if the land price is required for year 1995 then the LEV should be calculated with 1995 as the base year, and the revenue data used would be that received for successive forest rotations which were first established in 1995. The LEVs calculated for each year are plotted to generate a LEV curve which forms the base line from which to predict land price changes.

Where the real costs or revenues are expected to be different for successive rotations, the Present Net Worth (PNW) formula can be used, excluding land purchase costs and sale price, or land rentals.

$$PNW = \sum_{t=0}^{n} [R_t - C_t] \times \frac{1}{(1+i)^t} \qquad \text{(Equation 2)}$$

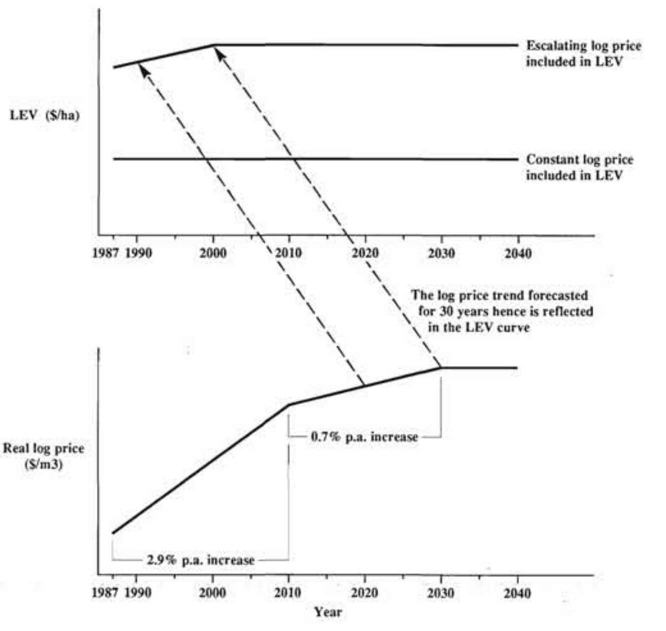
Where:

PNW = the present net worth
R_t = the revenues or positive cashflows in year t
C_t = the costs or negative cashflows in year t
t = the year in which the cashflow occurs
i = the interest (discount) rate
n = the maximum number of years in planning horizon

The planning horizon would need to be three or more rotations to equate to the LEV which is based on forest grown in perpetuity. The specific number of rotations required will depend on the predetermined rotation length, magnitude of cashflows and discount rate.

In the LEV equation the future log prices predicted when trees established now mature would normally be used. It follows that the trend in log prices 30 years plus from now could be expected to be reflected in a LEV curve, as depicted in the following graph (Graph 1). So if the log prices increase until year 2030, then the LEV calculated for each year would increase from 1990 to 2000. The LEV calculated for year 2000 would involve use of year 2030 log prices (assuming radiata pine crop with a rotation length of 30 years). If real log prices become static after this point, the LEV from year 2000 onwards would be the same. (Note: there might be some differences for a period resulting from production thinnings undertaken before the real log prices stabilise.)

GRAPH 1: Assumed Correlation Between Future Log Price Predictions and Land Expectation Values



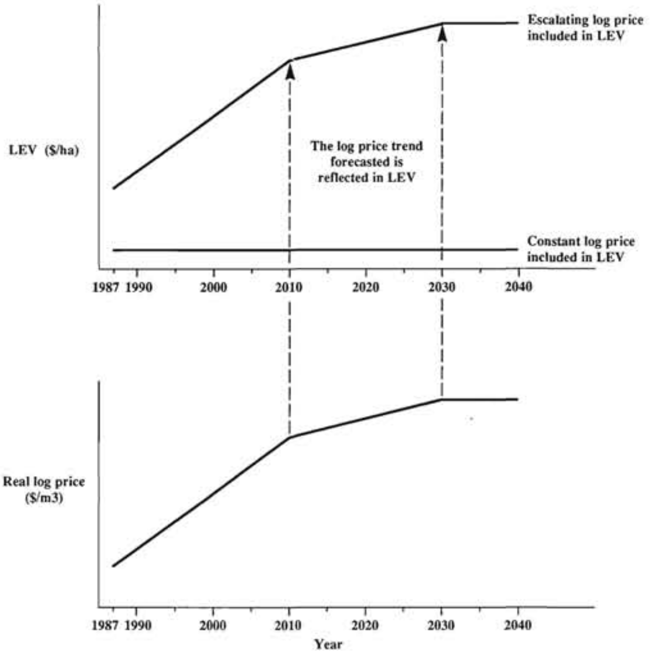
However, land valuers calculate the value of the land using **actual** current costs and returns of the most profitable land use. So, while the LEVs which are calculated using potential future log prices may provide the true or affordable value of the land (assuming future log price increases will eventuate), it does not provide a suitable base line for determining likely land values for rental purposes.

Land valuers will presumably continue to undertake valuations incorporating current costs and revenues, so the LEV curve would be more correctly derived a follows:

For each year of the planning horizon the LEV should be calculated using the forestry costs and log prices projected for that year only. For example, if the log prices escalate at 1.5%

p.a. from 1990 to 2030, to calculate the LEV for 1995, the log price in 1990 × 1.015^5 should be used in the LEV equation, and not the log price projected for 2025 (the year when trees planted in 1955 are assumed to mature). As an example, if it is assumed that the log prices escalate at real rates of 2.9% p.a. until 2010, and 0.7% p.a. to 2030, then remaining constant as predicted by BERL (1988), the trend would be directly reflected in the LEV curve shown in Graph 2. The degree of correlation bewteen the log price trends and the LEV curve will depend on the rotation lengths, the magnitude of log prices relative to the total investment cost, and the discount rate used.

GRAPH 2: Assumed Correlation Between Predicted Base Year Log Prices and Land Expectation Values



STEP 2: Derivation of land values from the LEV curve

If the LEV is higher than the current land value it is presumed that over time the market value of land will tend towards the LEV. This is for the assumed situation where land used for forest growing is only suitable for that land use alone. Obviously if a forest area is at a margin with other land-uses and the area is suitable for one or more other land-uses, changes in the profitability of other land-uses may become the land value determinant. For example, agricultural land prices often fluctuate as a result of prices received for agricultural produce on the world market. If agricultural produce prices increase dramatically this could influence or determine the land prices of those areas used for forest growing but also suitable for agriculture.

Where the LEV is less than the market value, it is presumed that either:

(a) the land use may change from forestry if the difference is sustained long term;
(b) the forest grower has to accept a loss, i.e. accept a lower post-tax discount rate of return on the investment;
(c) the land value will tend towards the LEV.

Obviously the LEV could be greater than, equal to, or less than the land price, depending on the location and type of forest proposed and the operational efficiency achieved. In this analysis, however, a scenario where the LEV exceeds the current land price was arbitrarily selected to illustrate the relationship between land prices and forest profitability. It is also assumed that the land will continue to be retained for forestry production and a fixed post-tax discount rate of return will be realised in perpetuity.

It is surmised that the land price changes would follow a similar trend to the LEV and the actual market land will tend towards the LEV curve over time. There would, however, presumably be a lag in land price changes due to:

(a) perception lag: time before the land market realises that the worth of the land has changed;
(b) land revaluation period: interval taken before the land is revalued and/or the land rental is reassessed.

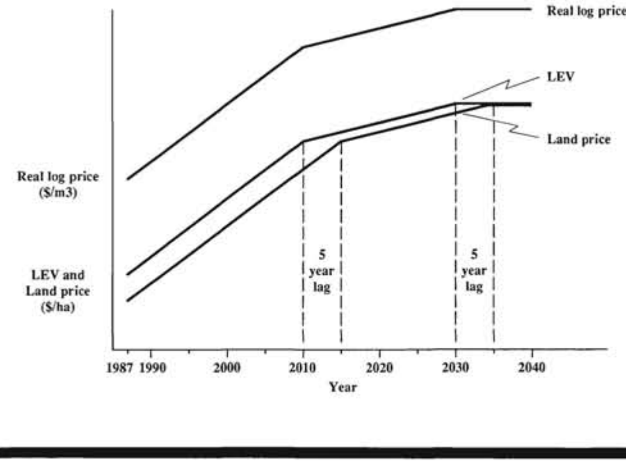
The determination of the lag (market responsiveness) is a critical factor in deriving the land value changes. The Valuation Department undertakes rural land valuations every five-year period on a rolling basis, or sooner in the event of a change of ownership. Presumably the market would perceive changes in forest profitability within the land revaluation period, so the maximum lag is probably less than five years. Some land valuations will account for the crop profitability changes sooner than others, depending on when the forest valuation was last done. A conservative approach would be, therefore, to use five years as the lag period. The lag effect could be greater, depending on the period of time between lease rental reviews.

The expected relationship in the short term is for the increased prices for logs to increase the forest profitability without an immediate impact on land prices. It is expected that the land prices will gradually increase as a result of increased forest profitability, and the land rentals will follow and tend towards the changing LEV, so eventually the margin between the LEV and the land rental cost will be reduced, assuming there are not abundant areas of suitable land available in the local area for forestry. In addition to this mechanism the increased log prices may attract further forest investment, and where land is a scarce resource this should also cause the land prices to increase in real terms.

The margin between the LEV and market land value may vary in relative terms between forests, depending on the ability of the landowner/forest grower to negotiate land rentals, the degree of accurate knowledge the landowner has on the changing potential forest profitabilities, and the demand for supply of land available for forestry. In this report it is assumed that the margin will be removed, which will have a consequential impact on the future land rentals.

The following diagram (Graph 3) illustrates the assumed relationship between log prices, LEVs and land prices.

GRAPH 3: Assumed Flow-on Relationship Between Log Prices, LEV and Land Prices



In Graph 3 the land price is shown to increase at a gradual continuous rate in accordance with the LEV trend. This is doubtful in reality because timber prices fluctuate, which should translate into land price fluctuations. For example, if the rate of increase in LEV has been significant for an extended period of time, and then suddenly diminishes or becomes static due to significant changes in market log prices, land prices may not respond accordingly, due to the lag effect, and could temporarily overshoot the true land value (LEV). Despite the possibility of fluctuations, step-wise or cyclical patterns, it is expected that over the longer term land prices will reflect the theorised change in LEVs. For this reason and because fluctuations are obviously not easily predicted the log price, LEV and land prices are represented by straight lines or smooth curves.

STEP 3: Determination of True Forest Valuations

If escalating log prices are being included in a forest valuation, increasing land prices should also be included because increased timber prices should translate into increased land prices over time. It could be argued that if increased forest profit resulting from increased log prices is absorbed by increasing land prices, and both forest and land do not have the same owner, then constant log and land prices should be used in the valuation. This would be incorrect, however, because:

(a) there is a lag between increased forest profits and increased land values; and
(b) maybe only a portion of the increased forest profit and hence LEV will be translated into higher land costs.

Note also that where the forest is on rented land the full effect of land costs on profit will not be felt because the land rent is only a small proportion, say 6 or 7%, of the unimproved land value; i.e. the full effect of land cost changes will be buffered.

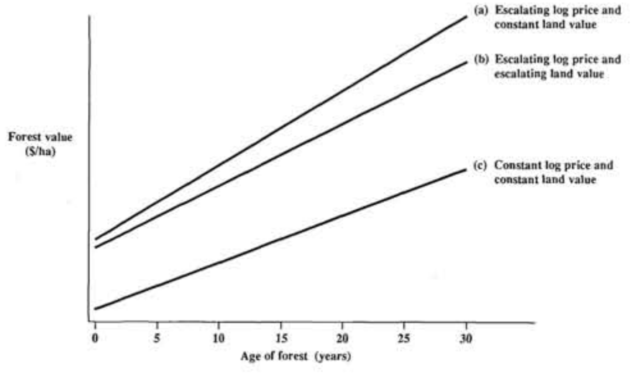
The above-mentioned methodology provides a mechanism for deriving changing land prices which should be used in several situations:

(a) If real log prices are accepted by a forest grower considering selling a forest area, the grower should account for land price escalations and incorporate progressively increasing land rentals in the forest valuation.
(b) In the case of joint ventures where there are distinct forest owners and landowners, or where forest growers lease land, and the land rental agreements between the landowner and the forest grower can be regularly adjusted for inflation **and** increases in real values, then more equitable land rental payments and/or stumpage shares would be derived if the forest valuations with escalating log prices also included escalating land rentals.

Forest Valuations undertaken by these parties should include the following costs and prices:

(a) real revenue escalations (i.e. projected log prices when the tree crop will be established);
(b) all growing costs to be incurred between present day and crop maturity (in constant current day dollar values – with an exception if the new forestry taxation regime is used in a valuation. An inflation rate profile over time should be used to deflate the cost-of-bush account to retain the relativity between the unindexed historical costs in the COB account, and the constant current day dollar values in the capital, land development and deductible expense accounts); and
(c) either:
 (i) if land purchased: the current land market value (or the purchase price) and the escalated land sale price at the end of the rotation (or annual rental derived from these values); or
 (ii) if land rental: the escalating land rent for each year from present to crop maturity.

The relative differences in valuations which are calculated according to conventional approaches (forest valued assuming consistent land cost and with or without escalating log prices) and the proposed approach are illustrated on Graph 4 by curves a, c, and b respectively.



GRAPH 4: Hypothetical Example of Relative Differences in Valuation Based on Use/Non-use of Escalating Log Prices and Land Prices.

Quantifying the Effects of Land Price Changes on Forest Valuations

The impact of excluding changing land prices from forest valuations which include escalating log prices can be quantified according to the following formula:

$$\text{Error in Forest Valuations (\$)} = \sum_{i=1}^{n} \sum_{j=1}^{m} ((Va_{ij} - Vb_{ij}) \times Area_{ij})$$

Where:

Va_{ij} = valuation of forest from crop type i in age class j, calculated with escalating log prices and constant land prices ($/ha)
Vb_{ij} = valuation of forest from crop type i in age class j, calculated with escalating log prices and escalating land prices ($/ha)
i = crop type
n = number of crop types included in forest valuation
j = forest age class
m = rotation length of crop type i (years)
$Area_{ij}$ = Area of forest from crop type i in age class j (ha)

Conclusion

Given that any substantial long-term real increases in log prices would affect land expectation values it is likely that prices of land currently used for forestry would change. This paper provides a theoretical methodology for forecasting and quantifying these land price increases in forest areas. Assumptions regarding lag periods and margins between the land expectation values and land prices may require further examination.

While land rentals may not represent a large proportion of total forestry growing costs on a per hectare basis, a slight increase in the rental compounded over the forest rotation represents a significant reduction in the profit margin. So in situations where the ownership of vast areas of forest is being separated from the land and log or timber product prices are expected to increase significantly, a consideration of this element in forest valuations is judged appropriate.

Acknowledgements

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INSTITUTE NEWS

From the President

Forestry's fantastic future

Browsing through an old National Geographic magazine I came across the lead article of the issue for September 1958 – "You and The Obedient Atom". The 51-page article began: "Abundant energy released from the hearts of atoms promises a vastly different and better tomorrow for all mankind.

As well as electric power, the article was confident about ships being nuclear powered. The Chief of US Naval Operations was quoted as saying: "Perhaps 10 to 15 years from now we will see several hundred ships with nuclear power". Aircraft propulsion, although difficult, was seen as a real possibility.

Most of the article was on the possibilities for fission energy – "a pound of fissionable material contains as much energy as 1500 tons of coal or 250,000 gallons of diesel oil". However, in 1958 the cost of nuclear-generated energy was still considerably higher than that from other sources. Fusion (deuterium – helium) knowledge was then very limited but its promise vast – "the enormous energy thus released may some day provide man with unlimited power".

The article also discussed the prospects for isotopes and for irradiation.

With the advantage of over 30 years of hindsight the benefits of isotopes in medicine, industry and research have lived up to their earlier expectations. The 1958 article was also realistic about the risks and the problems of nuclear waste disposal. However, the vision of cheap and unlimited energy from nuclear sources seems further away than ever.

Energy is now so essential to the world. Given unlimited, cheap and non-polluting energy most of the world's problems could be solved – except possibly those of politics and religion. One day there may be a breakthrough with nuclear or some alternative energy source, but this seems increasingly unlikely.

For the foreseeable future we are limited to the sun, the moon and the earth as the only reliable sources of future energy.

The earth's main contribution is geothermal. Currently this provides very little of our energy and although new ways might be developed to tap the heat of the earth's core that day still seems a long way off.

The moon's major contribution comes from the tides. But to date tidal forces have not proved anywhere near so successful as was once promised. Even if tidal generation is a possibility there are few sites where tidal power can be harnessed.

The sun therefore looks like the only possibility for providing 90 per cent, or more, of the world's energy needs. The sun will continue as it is now for about another five billion years. Currently the sun's major contribution is via fossil fuels – oil, gas and coal – all convenient and easily transportable forms.

The sun also manifests itself as an energy source in:

- hydro
- wind
- wood
- or some direct conversion process like photo-electric cells or chemical changing.

Fossil fuels will become increasingly economically limited. Perhaps even more important, the world is becoming increasingly concerned about releasing all that fossil carbon back into the atmosphere and so adding to the greenhouse effect.

Although hydro generation is an excellent energy source (and the promise of practical super conductivity could significantly improve efficiency in distribution and use) there are major limitations as to how many more dams the world can construct.

Wind power has some uses and we will undoubtedly see further developments. It is, however, doubtful if it will be realistic to have windmill generation everywhere. It also seems unlikely that our coastlines will be lined with wave generation plants. Since wind is always variable energy storage is always going to be a major cost. Wind power's future is likely as a topping up energy source.

Direct energy conversion by photo-electric cells or some chemical process has often been heralded as a possibility. However, to date no process looks like being very cost effective on a large scale. High capital costs will be a major factor. The large area required for light capture must result in all kinds of environmental problems. Power storage needs must also be a major cost as energy is most likely to be required when the sun's energy is least (night time and during the winter). Direct conversion of the sun's energy is at best only a limited option.

Wood, which is really only water, carbon dioxide and sun's energy, is on fundamental grounds by far the simplest and most practical means of tapping the sun's energy. Storage presents no problem – quite the opposite – the trees continue to store the sun's energy when they are not required. There are no real pollution problems. Wood actually reduces rather than worsens the greenhouse effect. Wood is an ideal fuel. To ensure that trees can withstand the destructive forces of storms wood has a structure that gives a high strength to weight ratio. These properties, and its fibre network, make wood an ideal provider of a large number of man's requirements other than food or clothing. Although wood is totally renewable management skills are still required to maximise production (and profit) and, to produce the widest range of wood products.

Unless there is some major breakthrough on the energy front which gives the world a cheap, unlimited, non-polluting, low risk and flexible energy source then wood (and forestry) seem certain to become even more important than they have in the past.

W.R.J. Sutton