Marked Based Income Approach for Forest Valuation

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SUMMARY

According to the International Valuation Standards (IVS), valuation should be primarily based on market prices. Using market approach for forest property valuation is difficult as sold forest properties are unique by the view of forest resources. The value of forest in Finland is mainly based on the growing stock volume and the quality of the stands. They variate a great deal between properties, and the purchase price register maintained by the National Land Survey of Finland does not include tree stand data.

Income approach is potential alternative for this kind of valuation since it takes into account the predicted growth and handling (e.g. cuttings) of the tree stands. However, the discount rate used in valuation affects a great deal the result of valuation. Thus, the discount rate should derive from the market so that the result could be market value. These rates (internal rate of return, IRR) were examined in this study.

In this study, it was combined approximately 1000 representative forest property transaction and their forest resource data. The data was provided by the Finnish Forest Centre. It had been produced from airborne laser scanning data with semi-automatic process. The data was simulated with Motti growth and yield simulator. As a result, discounting rate seems to depend on temperature sum, average stock volume and the proportion of the mineral soils.

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1. INTRODUCTION

The forest sector and industry have had a remarkable role in the Finnish economy for a long time. Nowadays, it covers 20 percent of the country's export income and provides 15 percent of the Finnish industry jobs. Forestry and forest industry has a key role in many regions in Finland. At the beginning of the 21st century, the role of the Finnish forest industry decreased, but it has taken its role back during last few years. Climate change has offered many possibilities to utilize Finnish forest in different bio productions like paper and packaging products and fuels. This has led to many significant investments in the Finnish forest industry.

There are 26.2 million hectares of forest in Finland, 86 percent of the land area. Non-industrial private ownership has a long tradition in Finland. Non-industrial private owners are the largest group of forest landowners. They own 53 percent of forest area. In addition, their share of the growing stock volume is 65 percent since the most of their land is located in the southern part of Finland.

There are some 632 000 people who own 347 000 forest holdings over 2 hectares. The size of a forest holding is 30.1 hectares on average. Generally, the forest properties have been owned by families, and forest holdings have been handed down from generation to generation. The most of the forest properties change their owners as inheritance, donation or in-family transaction. Only 15 percent of the properties are acquired from open market. The number of representative[1], over 2 hectares forest property sales, has been approximately 3000–3500 annually in recent years. Representative forest property transactions centre on small properties. Properties larger than 10 hectares are sold 1600–2000 per annum and properties over 100 hectares are offered seldom for sale.

Forest property transactions are made all over Finland. Generally, almost all sale offers and buyers had come from private people but the situation has changed slightly in past few years. Interest in forest investment has grown and banks have begun to establish forest funds which have bought forest properties. Large forest owner companies, especially UPM, have sold bigger holdings to the funds. Thus, the average size of the sold forest property in class over 10 hectares has increased from 30 hectares to 50 hectares during this decade. In addition, demand has raised prices. The median price of forest property larger than 10 hectare is around 2700 euros per hectare. It varies notably depending location. In the southern Finland median price is 3500–5000 euros, in the northern Finland 1500 euros and in Lapland 800–900 euros. The main cause of the price fluctuation is variation of the forest stand characteristics e.g. timber volume and their wood assortments and forest land site. In addition, there can be more potential buyers in the southern Finland which may increase market prices there.

[1] Representative forest sale = Not a transaction between relatives, unbuilt and includes only forest land

2. FOREST VALUATION IN FINLAND

Due to the strong forest sector in Finland, wood production is economically the most important mode to utilize forests. Therefore, forestry income affects the most the value of the forest properties. The most important sub value of the forest property is the value of tree stands. Non-monetary values like scenery, recreational values, and existence values are noticed nowadays. However, they usually do not have an effect on market prices.

According to the International Valuation Standards (2017), valuation should be based on market information. The market approach is preferred if relevant market information is available. However, transactions that are comparable are seldom made since properties differ notably from each other. Moreover, the Purchase Price Register of the National Land Survey of Finland does not include any characteristics of the forest property. Lack of stock and site productivity information on the Purchase Price Register is actually the greatest problem of the utilization of the market approach.

Forest valuation in Finland is based on the summation method which is an application of the long-term income approach. It is based on Martin Faustamann’s formula for calculating the bare land value, 1–4 percent interest rates in discounting factors are used. The summation approach has been used in Finland since 1930’s. The idea of the approach is to calculate stand-specific sub values separately and sum them together to each forest stand and then to the whole property. The sub values indicate the value of bare land after the final cutting, the expectation value of the seedlings and young stands and the cutting value. Cutting value is based on the volume of the wood assortments and the stumpage prices. Bare land values and expectation values are generally taken from tables. They are calculated by Forestry Development Centre Tapio, but various organisations used to have their own tables.

However, the sum value is usually higher than the market value. To reach the market value, it should apply a bulk discount. It has been between minus 50 and minus 10 percent. Discount rate is determined by a valuator and it depends on case, property’s characteristics and valuator’s expertise and skills. Discount rate is the weakest part of the summation approach since it is determined subjectively and it has significant effects on the value. Furthermore, the method is quite inflexible and it does not take account property’s characteristics as well as it could do.

Income approach is usually applied for investment calculations. Interest to apply it for objective forest valuation has increased in Finland. According to IVS, income approach leads to market value when parameters used in the approach are derived from market. The main problem has been to derive a discount rate from market data.

Income approach in forest property valuation differs from typical investment calculations by timing. Usually income approach or discounted cash flow methods are made for a few decades. The rotation periods used in forestry are 60–100 years in the southern Finland and longer in the northern part of the country. The approach is based on the prediction of the future cash flows. Costs and revenues are usually estimated with simulation and optimization software systems.

3. FOREST RESOURCE DATA

The Finnish Forest Centre has produced forest inventory data based on remote sensing since 2010. Earlier it based on standwise field inventories. The aim of the data production has been to serve private forest owners. Remote sensing inventory is based on orthophotos and airborne laser scanning (ALS) and it is partly automatized. Orthophotos are used for separate forest compartments[2] and ALS data for estimating stand characteristics and timber assortment volumes.

ALS data inventory is divided in to two methods: Area based method and Individual Tree Detection (ITD) method. Area based ALS inventory exploits low density laser scanning data. The method is based on canopy height distribution. In the method, percentiles of the distribution of laser canopy heights are used as predictors to estimate forest characteristics in some sampling area. It produces reliable estimates of stand level mean forest variables and data acquisition cost is comparable with standwise field inventories. Thus, area based ALS inventory is the main method for producing forest inventory data nowadays.

In the future, it could be possible to produce forest resource data with individual tree detection method. In the ITD method, tree height and crown width are measured and tree species determined, using high density laser scanning data. ITD can utilize both airborne laser scanning data and terrestrial laser scanning (TLS) data. ITD method leads to more accurate results but it needs high density laser scanning data which is considerably expensive to produce currently. (Holopainen 2011.)

The rotation of airborne laser scanning is planned to be ten years. Between inventories, forest resource data is updated by modelling and various notices. Most of them are notices of proposed cuttings.

4. SIMULATION OF FORESTS' GROWTH AND YIELD

Several simulation and optimization systems for forest management planning are developed in Finland. Natural Resource Institute Finland has developed Mela (MetsäLaskelma, forest computation) and Motti simulators. Simo (Simulation and Optimization) has been developed in University of Helsinki and Monsu in University of Eastern Finland. Mostly, they are used for assessing the effects of alternative forest management practices on stand development. They can be used for evaluating costs and incomes of forest property.

Motti simulator was used in this study because allows flexible use of discount rate. Motti includes both tree- and stand-level simulation parts. It uses linear optimization and it models growing in cycles of five years. Motti includes more than 400 tree or stock size, growth, development, mortality, treatment and wood production models. They based on long tradition of Finnish forest research. They include most recent research results. In addition, Motti can be calibrated using National Forest Inventory data (Salminen et al. 2005).

[2] Forest compartments are homogeneous areas by growing stock. They are usually delineated into uniform areas by future silvicultural treatments and cuttings. Usually forest valuation is made by valuating compartments individually.

Motti can predict growth for all major tree species and forest sites throughout Finland. However, the predictions are more reliable for forests in mineral soils than in peatland soils. A user is allowed to define forest management practises in Motti. In this study, recommendations from Best Practices for Sustainable Forest Management (2006) and Best Practices for Sustainable Forest Management in Peatlands (2007) were used. Motti simulates the first rotation period for the forest compartment on the grounds of source information. Costs and incomes are calculated and discounted to the present according to the simulation. Next rotations are simulated as per the best practices and the net income is capitalized to eternity. The sum of the first and the next rotation periods is the value of the compartment.

5. EMPIRICAL APPROACH

The aim of this study was to examine internal rate of return (IRR) of forest transactions made in 2015 and 1–6/2016. Thus, it is possible to develop an expert system for forest property valuation (Airaksinen & Hannelius 2010) and use the results of this study for discounting rate recommendations. In addition, another aim of this study was to examine how usable is the forest resource data. The forest resource data was used first time in this kind of market study. Earlier, the data collection has been carried out through intensive field work. Separate field inventory process is expensive and time-consuming.

The study focused on property’s value as forestry use. Only representative forest transactions were allowed. Limitation for size was a minimum of ten hectares. Properties under 10 hectares may have been bought due to other (i.e. recreational) values and therefore it did not take them into account. Although the focus was on forest properties, five percent proportion of arable land in a transaction was allowed. Moreover, there had to exist forest resource data from the transaction’s area provided by Finnish Forest Centre in order that the transaction was included to the study. It narrowed down transactions where the seller was a company since the Finnish Forest Centre had not produced the data from company owned areas.

Costs and stumpage prices were average numbers taken from the official statistics of the Natural Resource Institute Finland. Taxes were not taken into account.

The key steps of analysing data were:

1) Checking the coverage of the data from each property/transaction
2) Evaluation if the data is up-to-date or not (i.e. new cuttings using aerial images). In case there were new cuttings, it was possible to make correction to the data
3) Calculation of IRR and some other characteristics (i.e. average stock volume, area, development classes) using Motti simulator
4) Checking outliers and problematic events
5) Making statistical analyses and results

There were 1168 transactions of forest properties with forest resource data in the beginning of the study. However, there was lack of data in several properties and it had to drop 110 transactions for that reason. In addition, 59 transactions had to be removed for different reasons (for instance significant error in data, a property bought for agriculture or peat production etc.). Before statistical analyses, it was removed 26 transactions which internal rate of return were over 10 percent. They skewed result and were interpreted as outliers. They were either successful transactions from the view of the buyer, or the forest resource data of these properties included errors.

The sizes of the transactions were between 8.3 and 242.5 hectares. There were some transactions under 10 hectares since the registered size of the property and the size of the real forest land (excluded land under roads etc.) varied slightly. Purchase prices variated between 5000 and 747 000 euros. The average growing stock volume was 93m^3/ha which is lower than the average volume (113m^3/ha) in Finland according to the National Forest Inventory (Finnish Statistical Yearbook of Forestry 2014). The same discovery has been made in earlier studies (Hannelius 2000, Airaksinen et al. 2011). The study material is presented in the table 1.

Table 1. The study material of 973 transactions.

Variable	Mean	Std Error	Minimum	Maximum	Lower Quartile	Median	Upper Quartile
Price, €	76370	2403	5000	747000	34290	56000	90530
Area, ha	28,5	0,76	8,3	242,5	14,5	21,1	32,5
Price/ha, €/ha	2895	54,9	308	12970	1670	2561	3738
Average stock volume, m3/ha	93,3	1,44	0,0	284,8	61,0	88,7	120,8
IRR, %	4,7	0,04	1,7	10,0	3,7	4,5	5,4
Proportion of the minearal soils, %	74,8	0,80	0,0	100,0	59,6	82,1	96,0

6. RESULTS

The result of the study was that discounting rate depends on property's temperature sum, which indicates location, and average growing stock volume. In addition, the proportion of the mineral soils affects market value in the middle Finland where is a huge amount of peatlands. Comparison of the results between this study and earlier studies (Hannelius 2000, Airaksinen et al. 2011) is presented in the table 2. The rate of return in the lowest class has not changed but it has decreased significantly in bigger groups.

Table 2. Comparison of the southern and middle Finland's results between this study and earlier studies.

Year	1995			2006-2007			2015-2016		
Volume of growing stock, m3/ha	Obs, n	Price, €/ha	Rate of return, %	Obs, n	Price, €/ha	Rate of return, %	Obs, n	Price, €/ha	Rate of return, %
under 40	40	700	5,7	56	1952	3,3	5	2146	3,6
41-80	68	1029	8,5	72	2310	4,4	36	2984	4,0
81-120	73	1408	8,1	67	2884	5,1	77	3705	4,4
121-160	36	2059	8,4	22	3353	5,7	55	4815	4,6
161-200	18	2609	10,6	7	4558	5,8	32	6295	4,8
over 200	15	3451	13,1	3	8479	5,1	12	8573	5,2

According to the figure 1, results were widely distributed. One reason may be the use of the forest resource data. It is not as accurate as forest field inventory data which is used in earlier studies. However, it seems that average stock volume does not have as big effect on IRR as in the earlier studies.

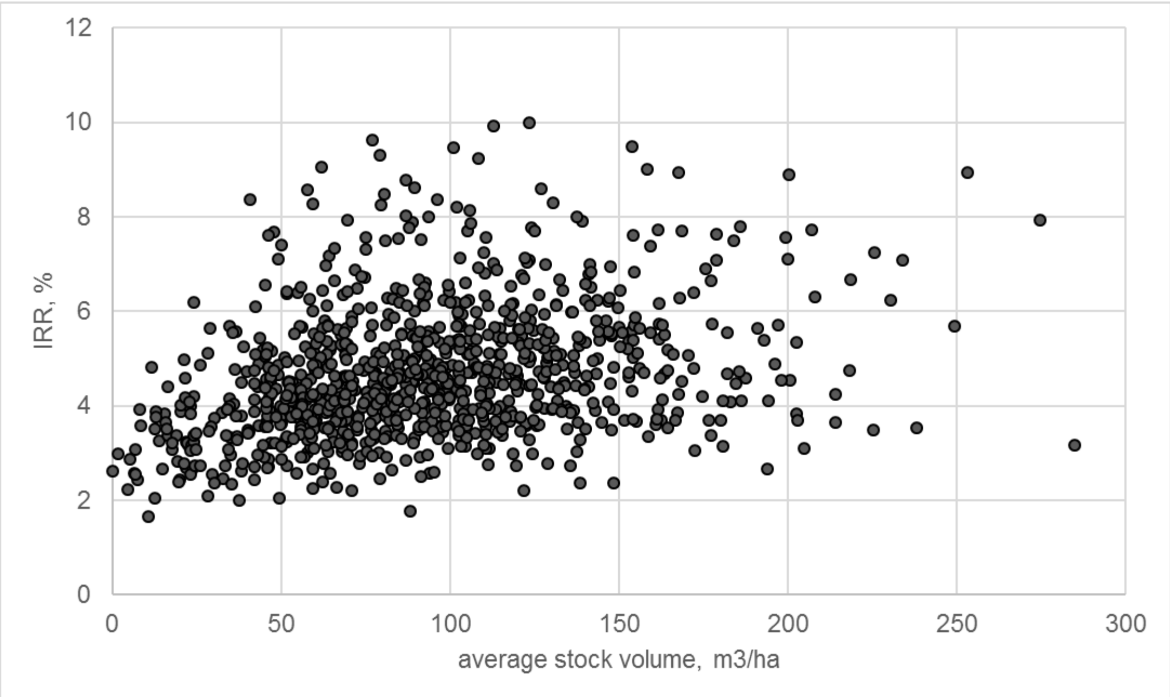

Figure 1. IRR as the function of the average stock volume.

Since the effect of the temperature sum was significant, data was divided in three sub groups depending on temperature sum. Classes were northern Finland (under 1000 d.d., degree days), middle Finland (1000–1200 d.d.) and southern Finland (over 1200 d.d.). A linear regression formula for each sub group and the whole Finland were calculated. Table 3 shows the results of the regression models for the IRR. Temperature sum is presented in figure 2.

Table 3. Regression models on IRR (%)

Variables	Estimate	N	R^2	Coefficient of Variation
Whole Finland		973	0,915	30,4
average stock volume	0,00964			
temperature sum	0,00382			
proportion of the mineral soils	-0,00719			
Southern Finland		217	0,937	26,3
average stock volume	0,00695			
temperature sum	0,00288			
Middle Finland		685	0,933	26,9
average stock volume	0,01533			
temperature sum	0,00372			
proportion of the mineral soils	-0,01018			
Northern Finland		71	0,924	29,6
average stock volume	0,02861			
temperature sum	0,00405			

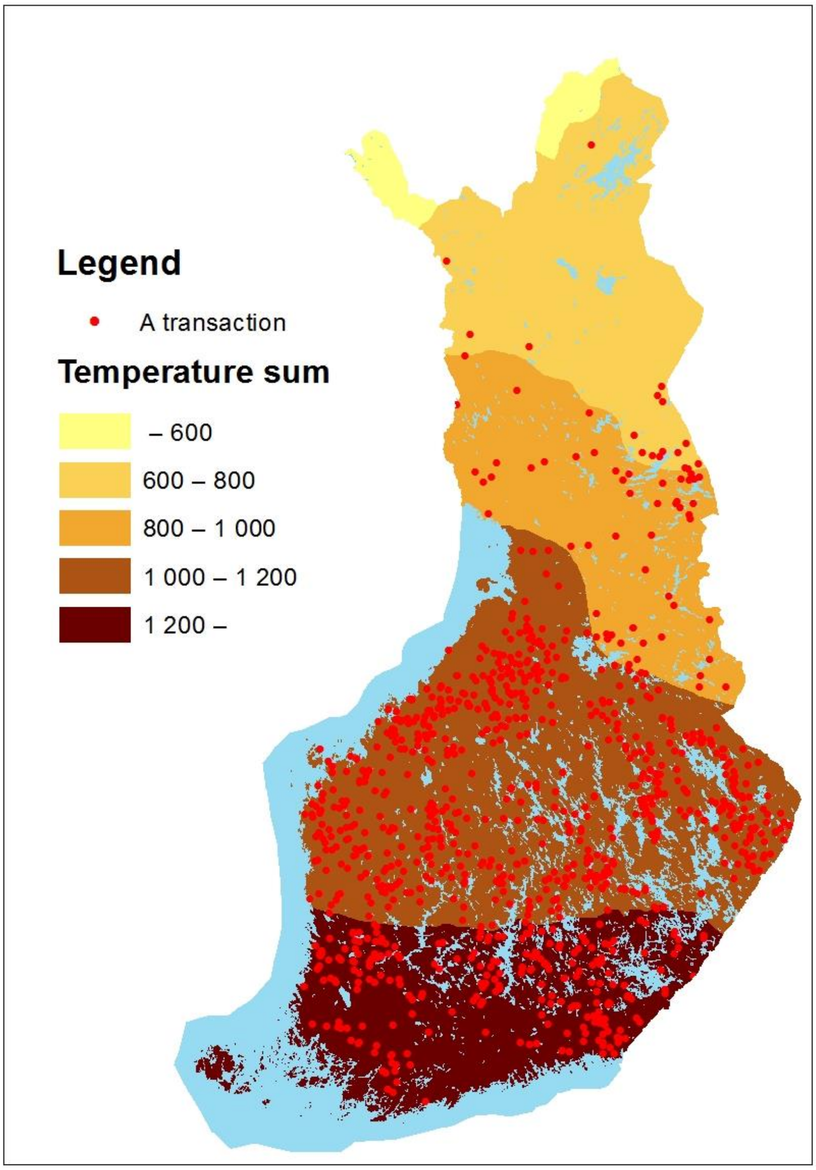

Figure 2. Temperature sum in Finland and locations of transactions in this study

7. DISCUSSION AND CONCLUSION

Market based income approach is a good alternative for forest valuation in Finland. It can benefit calculation basis (stumpage prices and forestry costs) from the market and it uses calculation models which are based on long Finnish tradition of forest research. However, there are many fields to be improved. Laser scanning technologies and applications are improving fast. Scientists are enthustiated about it in the field of forestry, too. There are a few applications which can improve the quality of the forest resource data:

- change from area based ALS inventory to individual tree detection

- Applying terrain laser scanning (TLS). Scanner can be combined i.e. with forest harvester and it can be seen which trees are kept after thinning
- ITD technologies in ALS and TLS allows to make “tree map” which include all trees and their quality

Even though producing forest resource data will be more accurate in the future, it does not mean that the data is better than nowadays. It should be up-to-date for that it is usable. Thus, information about cuttings and other forest use should get included in data. In addition, the data should get released fast from the database after a transaction, when discount rate is wanted to be derived or other types of market studies to be done. However, forest resource data seems to be usable for market studies.

Challenges in forest growth models, as we see it, are with peatlands. Marshes cover one third of the forestry land in Finland so the models should work well there, too. Another improvement part is to modelling uneven-age stands. The renewed Finnish Forest Act allows better to grow them nowadays and some forest owners have begun to use this method.

Valuator cannot affect abovementioned, but they should be considered when a market study is being made. The most remarkable issue which a valuator should take into account, is a discount rate. In some cases, a small change in a discount rate may have notable effects on the result. Thus, sensitive analyses are recommendable.

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