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WOODLOT PRICE FORMATION IN THE EARLY 1980s

METSÄLÖN HINNAN MUODOSTUMINEN
1980-LUVUN ALussA

The Society of Forestry in Finland
The Finnish Forest Research Institute
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The aim of this study is to explain both theoretically and empirically the formation of the unit price of a woodlot in the early 1980s in Finland. The structure of the market in which woodlot transactions take place is described by analyzing the volume of markets, the heterogeneity of the woodlots, institutional regulation of woodlot ownership and information concerning the market. The decision-making processes of both woodlot seller and buyer are examined using a theoretical model. Using a woodlot transaction sample for 1983 and 1984 woodlot unit price is explained empirically.

Keywords: forest ownership, woodlot purchasing price, woodlot sales price, woodlot transaction price.

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1. Introduction

Woodlot price formation is generally explained by one of two ways (Ahonen 1970, p. 66—67):

1) Traditionally, a woodlot is seen as an independent price forming object, the correct price of which can be determined using an objective method appropriate for a particular case. Deviations from the correct price are the result of lack of expertise on the part of the parties concerned, errors and other random factors.

2) According to the other point of view, a woodlot has no correct price as such. Instead, its price is formed as a result of mediation by the economic subject and the way he manages his finances. In a transaction situation, an entrepreneur defines for himself how much it is in his interest to pay or demand for the woodlot in question.

The above approaches may be referred to as the 1) objective and 2) subjective explanation models of woodlot price formation. When one wishes to draw the line between these approaches, one is often confronted by the question of whether a correct, given forestry time horizon and calculatory interest rate exist, or can these be freely selected by the woodlot owner (e.g. Endres 1919, pp. 13—17 and Mantel 1982, pp. 18—22).

The price of a woodlot is an agreement between the buyer and the seller. Various ex ante and ex post methods have been developed with the aim of improving the informative base of woodlot price negotiations. The foremost ex ante methods are

— the sum value method
— the discount (or productive) value method (Keltikangas 1964, p. 1).

Ex post examinations of the prices have, without exception, been carried out using the ordinary least square method with regard to various combinations of explanatory variables (e.g. Airaksinen 1988, Hannelius 1986, Kantola 1983).

This study was carried out in order to clarify the basis of woodlot price formation in Finland. It was initiated by Professor Jouko Hämäläinen from the Finnish Forest Research Institute by offering the woodlot price statistics gathered in collaboration with his department and the National Board of Survey as empirical background to the study. Valuable advice was also received from Professors Veli-Pekka Jarveläinen, Matti Keltikangas, Paiviö Ruhiainen, Jens Rivist and Juhani Weilandr, Dr. Mikko Tervo and Messrs. Leo Eerola, Olof Frölander-Ulf and Ilpo Tikkannen. The translation work was carried out by Mr. Erkki Pekkinnen. The financial support of the Departments of Social Economics of Forestry and the Department of Business Economics of Forestry at the University of Helsinki rendered the translation possible. At various stages of the data processing and manuscript preparation assistance was received from Heli Suuraininen, Raija Sinnalo and Kaisa Westin, and Harri Heinonen, Jarjo Karhula, Risto Laamanen and Ashley Selby.

I express my gratitude to all those who were involved in and contributed to this study. To my family and especially my wife Pirjo I am indebted for the patience permitting nightwork.

2. Aim of the investigation

The aim of this study is to explain, both theoretically and empirically, the formation of the unit price in woodlot transactions in the early 1980s in Finland. The study

— describes the structure of the market in which transactions take place
— examines, using a theoretical model, the decision-making process on the part of both seller and buyer during the transaction
— empirically explains the formation of the woodlot unit price by applying the above-mentioned model as a framework.

3. The premises of woodlot price formation

31. The structure of the woodlot market

This section deals with the structure of the woodlot market in Finland in the 1980s. The following features receive emphasis:

— volume of the market
— heterogeneity of the woodlots
— institutional regulation of woodlot ownership
— information concerning the market.

Volume

The real estate sales price statistics (for 1982—1987) and the annual statistics on farms (Official Statistics of Finland, NYT III:83, 1987) indicate that of the 300 000—350 000 woodlots in Finland 2.5—5 percent are being sold annually. The total area of the woodlots involved can be estimated to be less than 300 000 hectares (i.e. in excess of 1 % of the total forestry land area). This in turn indicates that the selling of a woodlot is a rare occurrence possibly caused by two reasons: woodlots are not demanded for sale or excessive numbers of woodlots are offered for sale. In other words, either woodlot owners are highly confident in the profitability of practising forestry or potential buyers lack the same confidence.

The heterogeneity of woodlots

Each woodlot is unique. The heterogeneity of woodlots being offered for sale can be examined in a number of ways:

— internal characteristics of the woodlot
— location of the woodlot with regard to economic activity
— its shape and degree of fragmentation
— its integration with the rest of the economy.
The internal characteristics include, for example, area, growing stock and growth dynamics, and the breakdown of the area into various land use categories. Location is indicated by transportation distances, times and costs of the products and factors of production between the woodlot and other locations of economic activity. There are no distinct indicators for shape and degree of fragmentation but they do influence the integrability of a woodlot with neighbouring woodlots, their divisibility and the profit-ability of practising forestry. The actual integration of a woodlot with the rest of the owning as well as its potential integration with the economy of the potential buyer both have bearing on the woodlot's price formation by way of constraints and other functionalities acting upon the owner's economy as a whole; e.g. finance constraint or tax function.

**Institutional regulation of ownership**

The real land ownership and land ownership in general is characterised by traditions which go back several centuries. The fundamental objectives of this regulation have varied in accordance with the political and economic circumstances. Usually this has resulted in a certain type of ownership being favoured or discriminated against. Regulation is largely based on the acts and regulations connected to their implementation. In the 1980's, the foremost pieces of legislation having either direct or indirect influence on the selling of woodlots are as follows:

- Maatalatalki (Farm Act) (Suomen säädöskokoe1ma 18.2.1977/188)
- Maaninhintakoe1ki (Right of Land Acquisition Act) (Suomen säädöskokoe1ma 26.5.1978/391)
- Sukupolvenvaihdolansäästö (Legislation concerning handing over of farm ownership to the younger generation and the Agricultural Income Tax Act, on the other hand, are indirect ones. It is often the former which decides whether a woodlot is put up for sale on the open market or whether it is handed over as inheritance. This legislation has a uniforming effect on both price formation, as well as the information connected to it (Luopumisopas 1977). The Agricultural Income Tax Act has an effect on the profitability of owning forest via the forest owner's taxation (Vehkamäki 1986, pp. 28–29).

In addition to the control imposed by legislation, the national budget is an important controlling instrument affecting woodlot sales. The budget defines, to a large degree, the funds available for the implementation of the above laws. Resource administrative decisions constitute a significant part of the implementation of the Farm Act and the Right of Land Acquisition Act.

**Information concerning the market**

The realisation of the purpose of the Farming Act by means of the Right of Land Acquisition Act's notification, permit and redemption procedures promotes the dissemination of information concerning transactions involving agricultural and forestry land to all buyer candidates fulfilling the conditions set down in legislation. The redemption right and obligation invested in the authorities have a uniforming effect on prices paid for land. Thus, legislation has limited the numbers of those requiring information found on woodlot transactions and the dissemination of information concerning them has been made the responsibility of the authorities and the information produced is of a uniform nature. The latter feature is even further influenced by the assessment methods used by the authorities and the advisory organisations serving agriculture and forestry.

### 32. Model examination

#### 32.1. Approach

The model examination includes specifying the woodlot transaction situation thereby enabling the theoretical examination of the bases of price formation of

- the minimum price charged by the owner (seller) for his woodlot
- the maximum prices offered by buyer candidates for the woodlot.

The aim is to deduce general, empirically verifiable regularities in special cases.

#### 32.2. Minimum selling price

The minimum selling price is deduced by

- formally describing the model
- interpreting of the model
- presenting the characteristics of the minimum selling price.

### Model

The woodlot owner's decision making situation at moment 0 is depicted by the following comparison set out in the form of inequalities:

\[
(3.1) \max \{A(h_0, K_0) - q(K_0) - i(t)\} + \begin{array}{ll}
\frac{h}{2} & \geq 0 \\
\frac{s}{2} & \geq 0 \\
\frac{l}{2} & \geq 0
\end{array}
\]

\[
[(1-p)(G(V_t, S_t, Q_t, K_t))] \geq (\lambda A + s K_0) \frac{1-p^n}{1-p}
\]

in which

- \(A\) = woodlot area
- \(h\) = cutting per unit area
- \(s\) = silvicultural investment per unit area
- \(i(t)\) = investment in associate livelihood
- \(G(V_t)\) = production function of associate livelihood
- \(K\) = capital stock of associate livelihood
- \(v(t)\) = total tax function
- \(R\) = taxable income
- \(F(t)\) = plan function of woodlot seller's economy expressed as present value of total consumption at moment 1
- \(Q(t)\) = forest management plan function
- \(V\) = growing stock
- \(S\) = silvicultural level
- \(Q(t)\) = plan function of associate livelihood
- \(N_t\) = extent of time horizon
- \(a\) = stumpage
- \(\alpha\) = rate of time preference
- \(\beta\) = unit price of woodlot (per unit area)
- \(e\) = selling price of associate livelihood (its capital stock)
- \(\tau\) = rate of return on financial investments
- \(v\) = woodlot seller's alternative earnings, e.g. wage income or pension

### Functions in the model

The following deals with the functions involved in the comparison (3.1) and their characteristics. The income function of an associate livelihood

\[
q = q(K_0)
\]

indicates the economic result of an associate livelihood (e.g. agriculture) at a moment as a function of the capital stock. It is defined so that

\[
q_0 > 0 \text{ and } q_{K_0} < 0.
\]

The total tax function

\[
(3.3) f = t + R
\]

is defined so that

\[
t_0 > 0 \text{ and } t_{K_0} \geq 0.
\]

The taxable income is defined as

\[
(3.4) R = A + Q(K_0)
\]

in which

\[
\tau = \text{taxable income from forestry determined administratively on the basis of site quality characteristics per unit area}
\]

The woodlot owner's plan function indicates the present value discounted to moment 1 of his intended consumption to be derived from economic activity, forestry and associate
livelhood during the planning period 1-N. The plan function

\[ F = F(AG(V_i, S_i), Q(K_i)) \]

is defined so that

\[ F_{AG} > 0, F_{AG,A} < 0; F_{Q} > 0, F_{QQ} < 0; F_{AGQ} > 0, \]

and that the Hessian matrix formed using the second derivatives is negatively definite. Using the per unit area defined management plan function, the contribution of forestry to the plan function of the owner’s economy is expressed as a function of the resources at the beginning of the planning period. These resources are the growing stock and the level of silviculture. This function may be realized by way of the planned cut or forestry surplus. For the sake of simplicity, the function in this connection is treated as a scalar-valued function, its practical applications are often vector-valued. The management plan function

\[ G = Q(V_i, K_i) \]

is defined so that

\[ G_{V} > 0, G_{VV} < 0; G_{K} > 0, G_{KK} < 0; G_{VK} > 0, \]

and the Hessian matrix formed from the second derivatives is negatively definite and the inheritance value constraints at the end of the time horizon are taken into account in it.

With reference to the above function, the plan function of the woodlot owner’s associate livelihood expresses the contribution of this source to the plan function of the economy of the owner. The function

\[ Q = Q(K_i) \]

is defined so that

\[ Q_{V} > 0, Q_{KK} < 0. \]

Model interpretation

If the left hand side of comparison (3.1) is greater than the right hand side, then

1) the woodlot owner will continue to be an active practitioner of forestry and the associate livelihood.

If the right hand side is greater than the left hand side, then

2) the owner of the woodlot will sell his real estate, invest the income received therewith in the capital market and commence to live on his alternative earnings and the interest received from his investments.

If (3.1) is realized as an equation, then

3) alternatives 1) and 2) are of equal value to the woodlot owner; i.e. his decision will remain undefined.

The lefthand side of the comparison includes the task of maximizing the present value of the woodlot owner’s consumption. The solution is realized as the regulation of instrument variables in the case where the owner decides to continue with active forestry and its associate livelihood. These instrument variables include cutting, investments in silviculture and its associate livelihood. The goal function of the maximization task (i.e. the lefthand side of comparison (3.1)) has been defined in such a manner as to make it concave with regard to the instrument variables. The opportunity set of instrument variables is convex and this is why the task has an unequivocal maximum

\[ V_i = V_s + g(V_s, S_0) - h_p, \]

in which the function

\[ g = g(V_s, S_0) \]

represents the woodlot’s concave total growth function (e.g. Vehkamäki 1986, pp. 9—12).

2) Changes in the index for the level of silviculture are controlled by investments in silviculture

\[ S_i = (1-a)S_{0i} + S_{0i} \]

in which

\[ a = \text{rate of deterioration of the level of silviculture.} \]

3) The capital stock of the associate livelihood is controlled by investments directed at it

\[ K_i = (1-\gamma)K_{0i} + h_p, \]

in which

\[ \gamma = \text{rate of deterioration of the capital stock.} \]

Characteristics of the minimum selling price

Assuming that the result of comparison (3.1) is equality, one is able to determine from it the minimum price that the woodlot owner should obtain for his woodlot to make it worth his while to sell it. If the righthand side of comparison (3.1) is greater than the lefthand side, then selling the woodlot is the better alternative for the owner. The condition in defining the minimum selling price is that the righthand side of comparison (3.1) is equal to or greater than the lefthand side. In the following, the unit woodlot price and the capital stock price of the associate livelihood are interpreted as constituting a total offer made by potential buyers resulting in the maximum total righthand side yield in comparison (3.1). The following designation is used:

\[ \lambda = \text{Unit woodlot price of best total offer} \]
\[ \kappa = \text{Unit price of capital stock of associate livelihood of best total offer} \]

The values for the initial stocks for the planning period 1-N, obtainable as the results to the maximum solution to the lefthand side of comparison (3.1), are designated by

\[ V_i^*, \ k_i^*, \ s_i^*, \ \text{growing stock} \]
\[ \text{S}_i^*, \ \text{level of silviculture} \]
\[ \text{K}_i^*, \ \text{capital stock of associate livelihood} \]

and the values of the respective instrumental variables by

\[ h > h_p > 0, \ \text{cutting} \]
\[ \text{g} > h_p > 0, \ \text{investment in silviculture} \]
\[ i > h_p > 0, \ \text{investment in associate livelihood}. \]

In other words, what is involved here is an internal solution to the opportunity set of the instrumental variables.

When the above variables are entered in comparison (3.1) and the condition connected to defining minimum selling price is taken into account, the following expression is obtained for the minimum selling price:

\[ \text{(3.12) } P = \frac{1}{\rho} \left[ \frac{1}{(1-r)} (A\theta h_0 + S_{0i}) - K_{0i} (1-r) + (1-\rho) (F(AG(V_i^*, s_i^*), Q(K_i^*))) \right] - \frac{1-\rho}{1-\rho \eta} \left[ (\nu \kappa^2 K_0 + 0) \right]. \]

In (3.12), \( \rho(\cdot) \) is the minimum selling price function. It is used in the following to examine the stability of the minimum selling price subject to a ceteris paribus assumption in relation to the following parameters involved in a woodlot selling decision situation:

- resources
- area
- growing stock
- level of silviculture
- capital stock of associate livelihood
- stumpage price
- rate of time preference
- capital market interest
- alternative earnings
- price of capital stock of associate livelihood
- taxable income from forestry per unit area.

The stability of the minimum selling price is examined by studying the sign of the first partial derivatives of the minimum selling price function derived in relation to the above-mentioned woodlot selling decision parameters. It should be pointed out that this examination does not explain the result of the comparison.
but merely the manner in which the minimum selling price behaves in relation to its parameters.

With regard to area, the partial derivative of the minimum selling price function is

\[
\frac{\partial M}{\partial A} = \frac{1}{\pi} \left[ 1 - \frac{\partial}{\partial \theta} \left( \frac{1}{G^2} + \frac{1}{1 - \rho N} \right) \right]
\]

which may be interpreted as the marginal periodical contribution of forest ownership. The latter term in expression (3.15)

\[
Z_{1} = (\alpha h_{p}^2 - \rho s)_{p} \frac{1}{\pi} \left[ 1 - \frac{\partial}{\partial \theta} \left( \frac{1}{G^2} + \frac{1}{1 - \rho N} \right) \right]
\]

may be interpreted as the periodical contribution to the forest owner's economy obtainable from marginal selling income at the minimum selling price in the capital market. When expression (3.16) is subtracted from expression (3.15), we obtain the sign of the partial derivative of the minimum selling price function deduced with regard to area. This sign depends on the sign of the difference between the woodlot's marginal contributions, owned and sold at the minimum price.

With regard to the growing stock, the minimum selling price function's partial derivative and its sign alternative are

\[
\frac{\partial M}{\partial G} = \frac{1}{\pi} \left[ 1 - \frac{\partial}{\partial \theta} \left( \frac{1}{G^2} + \frac{1}{1 - \rho N} \right) \right]
\]

which is quite a reasonable assumption.

With regard to the level of silviculture, the minimum selling price function's partial derivative and its sign alternative are

\[
\frac{\partial M}{\partial \tau} = \frac{1}{\pi} \left[ 1 - \frac{\partial}{\partial \theta} \left( \frac{1}{G^2} + \frac{1}{1 - \rho N} \right) \right]
\]

The above sign alternative is valid on the condition that

\[
\frac{\partial}{\partial \theta} \left( \frac{1}{G^2} + \frac{1}{1 - \rho N} \right) < 0
\]

323. Maximum purchasing price

The procedure for deducting the maximum purchasing price is the same as that used for the minimum selling price: description and interpretation of a formal model, presentation of the characteristics of the maximum purchasing price. The symbols used in describing the woodlot buyer's decision making situation are much the same as those used for the woodlot seller.

Model

The basic decision-making situation on the part of the woodlot buyer at moment 0 is described using the following comparison written in the form of inequalities:

\[
\frac{\partial M}{\partial \alpha} \geq 0
\]

The above mentioned sign alternative is valid on the condition that

\[
\frac{\partial}{\partial \theta} \left( \frac{1}{G^2} + \frac{1}{1 - \rho N} \right) < 0
\]

which is quite a reasonable assumption.

With regard to the stampage price

\[
\frac{\partial M}{\partial \tau} > 0
\]

With regard to the rate of time preference

\[
\frac{\partial M}{\partial \rho} < 0
\]

With regard to the rate of return on financial investments

\[
\frac{\partial M}{\partial N} = \frac{1}{\pi} \left[ 1 - \frac{\partial}{\partial \theta} \left( \frac{1}{G^2} + \frac{1}{1 - \rho N} \right) \right]
\]

\[
\mu^2 \frac{\partial M}{\partial \mu} = \frac{1}{\pi} \left[ 1 - \frac{\partial}{\partial \theta} \left( \frac{1}{G^2} + \frac{1}{1 - \rho N} \right) \right]
\]

\[
(1 - \rho) \mu \frac{\partial M}{\partial \mu} = \frac{1}{\pi} \left[ 1 - \frac{\partial}{\partial \theta} \left( \frac{1}{G^2} + \frac{1}{1 - \rho N} \right) \right]
\]

\[
\mu^2 (1 - \rho) \frac{\partial M}{\partial \mu} = \frac{1}{\pi} \left[ 1 - \frac{\partial}{\partial \theta} \left( \frac{1}{G^2} + \frac{1}{1 - \rho N} \right) \right]
\]
Model interpretation
If the lefthand side of comparison (3.28) is greater than the righthand side, then

1) it is not profitable for the buyer to purchase the woodland in question.

If the righthand side is greater than the lefthand side, then

2) it is profitable for the buyer to purchase the woodland in question.

If the comparison is realized as an equality, then

3) the woodland buyer’s decision remains undefined.

The solutions to two maximization tasks are thus being compared. On the lefthand side the object is the maximization of consumption with the help of the initial woodland and associate livelihood. And on the righthand side the effects of the woodland which is the object of purchasing have been connected to the maximization task. The object functions have been defined as being strictly concave with regard to the instrument variables and the opportunity set of instrument variables is convex.

Characteristics of the maximum purchasing price

By assuming the result of comparison (3.28) to be an equality, it is possible to go on to solve the maximum price that it is in the interests of the woodland buyer to pay. The designation

\[ \lambda^* = \text{unit price demanded by the seller for the woodland in question.} \]

The initial stocks of the planning period 1-NQ obtained as the result of the maximum solution for the lefthand side of comparison (3.28) are designated by

\[ \psi^1, \text{ growing stock} \]
\[ S^1, \text{ level of silviculture} \]
\[ K^1, \text{ capital stock of associate livelihood} \]

and the values of the instrument variables by

\[ \psi^1 \succ \psi^0 > 0, \text{ cutting} \]
\[ S^1 \succ S^0 > 0, \text{ investment in silviculture} \]
\[ K^1 \succ K^0 > 0, \text{ investment in associate livelihood} \]

if the condition

\[ (3.37) \quad \pi^p \succ \lambda^* \]

is realized, then the woodland transaction is feasible. The maximum purchasing price is used next to examine its stability with regard to the following purchase decision situation parameters:

- stocks of the woodland which is the object of purchasing
  - area
  - growing stock
  - level of silviculture
  - taxable income per unit area for the woodland which is the object of purchasing
  - capital stock of the livelihood
  - self-financed share of the woodland purchase
  - stumpage price
  - rate of time preference
  - capital market interest rate
  - cutting revenue finance.

The above parameters are examined in the same manner as was used for examining the minimum selling price.

With regard to the area, the examination of the sign alternatives of the maximum purchasing price’s partial derivative

\[ (3.38) \quad \pi_{\psi^p} \succ 0 \]

may be changed for examining condition

\[ (3.39) \quad X_{\psi^p} \succ X_\lambda^* \]

i.e. for examining the area-based marginal benefit and the mean benefit of the woodland which is the object of purchasing.

With regard to the growing stock, the sign of the maximum purchasing price function’s partial derivative is

\[ (3.40) \quad \pi_{\psi} \succ \pi_{\psi^0} > 0 \]

on the condition that

\[ (3.41) \quad \psi > 1 \]

which is a realistic assumption.

With regard to the level of silviculture, the sign of the maximum purchasing price function’s partial derivative is

\[ (3.42) \quad \pi_{S} \succ \pi_{S^0} > 0 \]

on the condition that

\[ (3.43) \quad \pi_{S^0} > \frac{G_f (1 - \sigma)}{\rho \sigma} \]

i.e. the initial level of silviculture must be a reasonable one.

With regard to the woodland’s administratively defined taxable income per unit area, the sign of the maximum purchasing price function’s partial derivative is

\[ (3.44) \quad \pi_{\psi^p} = t_k \frac{1}{AZ} < 0 \]

With regard to the capital stock of the associate livelihood, the sign alternatives of the maximum purchasing price’s partial derivative are

\[ (3.45) \quad \pi_{K} = (1 - \rho)(1 - \sigma)(F_G Q_k - F_G Q_k + q_k t_k) - t_k \frac{1}{AZ} \]

i.e. the effect of the capital stock of the associate livelihood depends on the effect of the woodland transaction on the economic plan function and tax function.

With regard to the self-financed share, the examination of the sign alternatives of the maximum purchasing price’s partial derivative

\[ (3.46) \quad \pi_{\psi} \succ 0 \]

may be done by examining condition

\[ (3.47) \quad \frac{\pi_{\psi^p}}{1 - \rho} \frac{1}{AZ} < 1 \]

where the left-hand side is the unit loan’s present value as a function of the purchaser’s time preference and the interest rate of the loan.

The partial derivative expressions deduced with regard to the other purchasing decision situation parameters are not presented. Their signs are as follows:

With regard to the stumpage price

\[ (3.48) \quad \pi_{\psi} \succ 0 \]

With regard to the rate of time preference

\[ (3.49) \quad \pi_{\psi} \prec 0 \]

With regard to the capital market interest rate

\[ (3.50) \quad \pi_{\psi} \prec 0 \]
The following additional constraint is introduced to the right-hand side of (3.28)

\[(3.51) \quad \lambda^2 (\alpha h_0 - \mu \lambda^2) \geq 0,\]

e.g. the self-financed share of the purchase is to be financed by means of the cutting revenue from the woodlot which is the object of purchasing. The tightness of the constraint in case it is binding is formally depicted by the Lagrangean coefficient associated with the constraint (3.51)

\[\lambda > 0.\]

With regard to the tightness of the cutting revenue finance the sign of the partial derivative of the maximum purchasing price equation is

\[(3.52) \quad \frac{\partial \pi}{\partial \lambda} < 0,\]
e.g. the decrease in the initial growing stock for the planning period I-Np caused by the cutting is taken into consideration. In case the constraint (3.51) is not binding, the influence of the cutting revenue finance is undefined in the framework of the model used.

324. The transaction situation

According to the above examination, a woodlot transaction is possible between such a seller and such potential buyers between whom the following initial transaction situation prevails

\[(3.53) \quad \pi \leq \pi^* \leq \lambda^* \leq \pi^t\]

and

\[(3.54) \quad \lambda^* \leq \pi^t\]

\[(3.55) \quad \lambda^* \geq \pi^t.\]

When a transaction takes place

\[(3.56) \quad \pi \leq \lambda \leq \pi^t,\]

in which

\[\lambda = \text{unit price which realizes the transaction}\]

and

\[(3.57) \quad \pi^t \leq \pi^t.\]

Competition between potential buyers depends on the information structure of the market. Assuming that perfect knowledge prevails, then in a situation with two or more potential buyers, whose maximum purchasing price function realizes condition (3.55), the potential buyer who possesses the second highest maximum purchasing price function defines the unit price which realizes the transaction. In a situation with only one potential buyer whose maximum purchasing price function realizes condition (3.55), then one or the other or both sides of (3.56) are realized as an equality.

4. Empirical examination

41. Statistical material

Hypotheses deduced from the model discussed in Chapter 3 were tested using the same material as employed by Airaksinen (1988) and Hannelius (1988). The material contains information on 574 woodlot transactions (minimum area of 10 hectares) from 1983 and 1984, of which 432 representative transactions were selected for this investigation. Representativeness here means that the transactions selected have not been between relatives. No extra conditions have been applied to the transactions and each woodlot was an unequivocally defined area (Hannelius 1988, pp. 9–14).

The following variables have been selected or formed from the above material for this study:

\[Y = \text{unit price of the woodlot (FIM/0.1 ha)}\]
\[X_1 = \text{total area of the transaction (0.1 ha)}\]
\[X_2 = \text{ratio of forest area to total area (relative figure)}\]
\[X_3 = \text{mean increment (m}^3/\text{ha/yr)}\]
\[X_4 = \text{distance from woodlot to nearest densely populated area (km)}\]
\[X_5 = \text{buyer's status (farmer or other private person = 1, others = 0)}\]
\[X_6 = \text{loan finance per unit area (FIM/0.1 ha)}\]
\[X_7 = \text{cutting revenue finance per unit area (FIM/0.1 ha)}\]
\[X_8 = \text{sawtimber per unit area (m}^3/\text{0.1 ha)}\]
\[X_9 = \text{need for silvicultural work (FIM/ha)}\]
\[X_{10} = \text{woodlot's location county (Hame or Kymi or Mikkel, 1, other counties = 0)}\]
\[X_{11} = \text{development of locally taxed per-capita income in woodlot's location municipality (income ratios for 1983 and 1980)}\]
\[X_{12} = \text{mean forest taxation site quality (0.1 m}^3/\text{ha/yr)}\]
\[X_{13} = \text{length of shoreline (m/0.1 ha)}\]

The variables are presented graphically by means of Box-and-Whisker Plots in Appendix. Also two-variable scatterplots (Draftsmen Plots) for all combinations of variables are presented in Appendix. The explanatory variables are defined as follows:

Area

The total area involved in the woodlot transaction (X1) is used to operationalize the woodlot transaction area; the total area may also include land belonging to land use categories other than forestry. The aim is to prevent the other land use categories from affecting unit price formation by using as a variable the ratio (X2) of forest land to total land area involved in the transaction. Land area other than forest land consists mainly of poorly productive and underproductive land (Hannelius 1988, pp. 9–14).

As a further means of eliminating the influence of other land use categories, the following variables are employed: development of locally taxed per-capita income in woodlot's location municipality (X11) and length of shoreline (X13).

Growing stock

Sawtimber per unit area (X8) is used to operationalize the growing stock in the model examination. Mean increment (X3) is included as a means of taking into account the structure of the growing stock. It also gives an indication of the long-term cutting opportunities in the woodlot.

Level of silviculture

The need for silvicultural work per hectare (X9) is used to operationalize the level of silviculture. The need for silvicultural work has been determined as the aggregate sum weighted by costs per hectare of urgent silvicultural jobs deemed necessary in conjunction with the drawing up of management plans. The cost weightings are based on the average costs for the whole country in 1984 (Official Statistics of Finland. SVT XVII A:17. 1986).

Taxable income

The mean site quality (X12) of the woodlot is used to operationalize taxable income.

Stumpage price

The location of the woodlot is one of the most stable determinants of the stumpage price, and that is why the distance from the woodlot to the nearest densely populated area (X4) and the dummy variable formed from the county of location (X10) are used to
operationalize the stumpage price. The woodlot’s actual mean stumpage price is not used; instead, the variables referred to in the above have been used to prevent the growing stock, structure of extracted timber and the market fluctuations from momentarily affecting the stumpage price. The dummy variable formed using the county of location is intended to depict the demand for round timber and its structure is the outcome of an experiment based on the distribution of wood industry enterprises in the various counties (e.g. Statistical Yearbook of Finland 1987).

**Government regulation of forest ownership**

It is assumed that regulation of forest ownership by legislation will lead to improved market information for private buyer candidates as well as favouring private forest ownership by means of loans at low rate of interest. These factors are operationalized using the dummy variable (X5) which is given the value 1 when the buyer is a private person; otherwise, its value is zero.

**Terms of finance**

The operationalization of the terms of finance is carried out indirectly by means of using per-unit-area loan financing (X6) because individual parameters for terms of finance are not available. The effects on the woodlot price of revenue obtained from cutting carried out in connection with the transaction are estimated by using as a variable the per-unit-area financing with revenue from cutting (X7).

**42. Method and results**

The econometric methods employed are the ordinary least-squares-technique (OLS) and the two-stage least squares-technique (2SLS). OLS is applied in order to estimate the coefficients of the transaction price equation and 2SLS when the coefficients of equations from a simultaneous equation system are considered (Koutsosyaninis 1981).

**Simultaneous consideration of selling and purchasing price equations**

The coefficients of the selling and purchasing price equations are estimated from the equation system specified as follows:

**Selling price equation**

\[(4.1) \quad Y^* = f(X_1, X_3, X_4, X_8, X_{10}, X_{11}, X_{12}, X_{13})\]

**Purchasing price equation**

\[(4.2) \quad Y = f(X_1, X_2, X_6, X_7, X_8, X_9, X_{10}, X_{12})\]

**Loan financing**

\[(4.3) \quad X_6 = f_{X_6}(Y^*, X_4, X_5, X_7, X_8, X_{10})\]

**Equilibrium condition**

\[(4.4) \quad Y^* = Y_d\]

The equation system is specified by leaving variables out of some equations so that the identification of selling and purchasing price equations is realized. The hypotheses concerning the signs of the coefficients of selling and purchasing price equations are as follows

\[
\begin{align*}
&X_1 \quad X_2 \quad X_3 \quad X_4 \quad X_5 \quad X_6 \quad X_7 \quad X_8 \\
&Y_s \quad +/\quad +\quad +\quad +\quad +\quad +/\quad +/\quad +
\end{align*}
\]

where X6, X7 are the computed values of the exogenous variables using the reduced form coefficients.

The sign hypotheses are concluded from the theoretical examination of the minimum selling price and maximum purchasing price. It is to be kept in mind when the specification and hypotheses of the above system are considered that

- the system is specified in the framework of the available data which does not contain variables concerning e.g. the seller’s alternative livelihood or the buyer’s economic state needed for identification of the equations.

**Transaction price equation**

The transaction price is specified with a single equation as a function of exogenous variables

\[(4.5) \quad Y = f(X_1, X_2, X_3, X_4, X_5, X_8, X_9, X_{10}, X_{11}, X_{12}, X_{13})\]

The hypotheses concerning the relationships between the dependent variable, woodlot unit price, and the independent, exogenous variables concluded from the theory derived above are as follows:

\[
\begin{align*}
&Y \quad +/\quad +\quad +\quad +\quad +\quad +\quad +\quad +\quad +\quad +
\end{align*}
\]

\[
\begin{align*}
&Y \quad X_1 \quad X_2 \quad X_3 \quad X_4 \quad X_5 \quad X_8 \quad X_9 \quad X_{10} \\
&\text{Constant} \quad -261.2 \quad -332.4 \quad -476.8 \quad -2.2 \\
&\text{I/X1} \quad 18173.3 \quad 4035.5 \quad 16540.0 \quad 255.2 \\
&\text{X2} \quad 294.5 \quad 277.9 \quad 5.0 \\
&\text{X3} \quad 62.5 \quad 5.1 \quad 0.1 \\
&\text{X4} \quad 0.6 \\
&\text{X5} \quad -88.5 \quad -1.3 \\
&\text{X6} \quad (7.0) \quad (6.3) \quad (7.9) \\
&\text{X7} \quad (4.7) \\
&\text{X8} \quad 84.4 \quad 150.5 \quad 85.0 \quad 1.4 \\
&\text{X9} \quad (19.9) \quad (18.4) \quad (20.7) \quad (19.4) \\
&\text{X10} \quad -0.2 \\
&\text{X11} \quad 209.9 \quad 172.6 \quad 185.0 \quad 3.5 \\
&\text{X12} \quad (7.6) \quad (6.3) \quad (7.0) \quad (7.4) \\
&\text{X13} \quad 249.2 \quad 202.6 \quad 4.3 \\
&\text{X14} \quad (3.3) \quad (2.8) \quad (3.4) \\
&\text{R}^2 \quad 0.73 \quad 0.74 \quad 0.75 \quad 0.77 \\
&F \quad 147.3 \quad 157.7 \quad 159.5 \quad 177.8 \\
&d.f. \quad 423 \quad 423 \quad 423 \quad 423
\end{align*}
\]

\[
\begin{align*}
&\text{Table 1. Estimation results of woodlot price equations} \\
&\text{Variable} \quad \text{Selling price, } Y^* \quad \text{Purchasing price, } Y \quad \text{Transaction price, } Y \quad \text{Square root of } t\text{-value, } \sqrt{t}
\end{align*}
\]

Other signs of the coefficients in Table 1 are as expected on the basis of the theoretical examination. The coefficients for the transaction price equations are calculated by using only the exogenous variables having a statistically significant coefficient (| t | ≥ 2.0).
5. Discussion

In this study woodlot price formation has been examined theoretically with the help of the seller’s minimum price and the buyer’s maximum price. A woodlot transaction is made possible if the maximum price is equal to or greater than the minimum price. Both of these prices have been derived from a comparison in which, on the one side, the woodlot which is the object of the transaction is a part of the decision-maker’s (i.e. seller or buyer) economy and, on the other side, economic activity is conducted without the woodlot which is the object of the transaction. The minimum and maximum woodlot price is derived from its net contribution to the decision-maker’s economy. This procedure can be seen as complying with the productive value method, but it does share some common features with the sum value method, too. In the method applied, the conditions sought for the price effects of the growing stock and level of silviculture are analogical to the sum value method’s expected values for bare land and growing stock and the cost values of establishing and tending young stands.

Although the theoretical examination leads to the conclusion of explaining woodlot unit price formation via subjective decision-maker premises, it does appear that, given the institutional circumstances in which the statistical material of the empirical study was collected, price formation takes place mainly on the basis of the characteristics of the woodlot in question.

In future empirical research work, special attention has to be given to the choice of relevant variables and to the relevant definition of the population of the woodlot transactions. In this study the available investigation data was limited to the characteristics of the woodlots so that the subjective points of view of the decision-makers could not be adequately taken into consideration.

Attention is also to be given on administrative processes in the woodlot price formation. A good improvement of the administrative practice applied can be gained, for example, from court cases involving land acquisition permits (see Wiriländer 1984, pp. 25—60). It would seem that in practice woodlot prices are determined in a very stereotyped manner, and the new owner of a woodlot is determined administratively from within that group of potential buyers whose maximum purchasing price exceeds the price obtained using a rule of property assessment applied by authorities.

To compare this study to most of the other related studies (e.g. Kantola 1979, Matikainen 1979) is pointless because the statistical material used in them is from a period when a different type of forest ownership regulation was in operation or because of the different problem formulation (e.g. Hannelius 1986, Airaksinen 1988). Generally speaking, comparing price formation at different periods of time is made difficult by the fact that forest ownership is controlled by highly flexible legal phrasology via which some legislative power has been transferred to the administrators. Hannelius (1986) has used regression analysis to explain the transaction price. The independent variables employed were the cutting value of the woodlot, mean development class and proportion of sawtimber in the growing stock. Using the same statistical material, Airaksinen (1988) employed regression analysis to study the dependence between the woodlot’s total selling price and the sum value in order to determine the sum value correction factors. The premises in the studies conducted by Hannelius and Airaksinen differ so much from the present study that there are no grounds for comparison. In this study the purpose has been to explain the woodlot price formation from the economic point of view. The aspects of justness, objectivity and reasonableness of the woodlot price which are important in the surveying and administration are ignored.

References


Total of 22 references

Seloste

Metsälin hinnan muodostuminen 1980-luvun alussa

Metsälin hinnan muodostumista selitetään tavallisesti objektiiviseen ja subjektiiviseen nimiaille liittyvään lähde- tavoille. Ensinnäkin tavan kannattajat pitävät metsälin itäistenä oman arvon muodostavaa objekti- na, jonka oikea hinta voidaan määritellä objektiivisella, kuhunkin tapaukseen sopivalla menetelmällä. Subjektiiviset ymmärtävät kuitenkin, että metsälin voi olla oikeasta siitä itsestään johtuvaan hintaan, vaan että hinto muodostuu vain taloutta harjoittavan subjektiin ja hänen taloudensuunnan valikkeilla.

Tämän tutkimuksen tavoitteena on selittää metsälilin hinnan muodostumista Suomessa 1980-luvun alku- puoliskolla sekä teoreettisesti että empirisesti. Teoreettisesti tarkasteltava aloite aloitetaan metsälinmarkkinoiden ku- vauksella, jossa todetaan:

1) Suomen metsälöiden lukumäärästä 2,5—5 prosent- tie ja pinta-alasta runsaasti on ollut kaupan

kohteena vuosittain ajanjaksona 1982—1987, ts. metsälökauppa on havainnoinut ilmiö.

2) Metsälö ovat erilaisilta metsäiläistä omia sukuu- sa, sijaintinsa, muotonsa, pirstoutnutuuisuutta, in- tegroitavuutta suhteen.

3) Metsälinomistus saattaa institutionalisointia voimakkaasti. Tärkeimmäksi 1980-luvulla metsälökaup- paan vaikuttaneet säädetökset ovat

—a milialaki
— maan hankintakoeuksilaki
— sukupuolenvahdosläkikesäntö
— maatalouden tuloverolaki.

Mainituihin joitakin oikosuositeltuaan on ollut vakuutettu välittömästi metsälöiden hinnan
muodostumiseen ja sen perustana olevan tiedon
saatavuuteen.
Rekisterissä tarkasteltua jatketaan määrittämällä metsälökaupanotteilta, jonka avulla tutkitaan
— omistajan (myyjän) metsälöstä oman valinnan vähimmäismäärä
— ostajahedhukkaiden metsällöstä tarjoamien enimmäismäärä

muodostumisen perusteita. Tavoitteena on johtaa määritetystä erityispaikasta tilastollisesti todennettavaksi säännönmukaisuus.

Vähimmäismäärävastuun omaisuuksien tarkastelemiseksi määritellään tilanne, jossa metsäomistajan
on päättävä
— jatkakko hän aktivisesti metsätalous ja sen liitännäsinäkemin harjoittamista vai
— siirtyy hän elämään eläkkeellään ja reaalimaisuutta myynnistä saamillaan pääomatoimilla.

Metsäomistajan jatkamisvaihtoehto kuvataan mallilla,
jossa hän maksimoi kulutuksensa aikomus hark
kuun, metsänhoitoinvestoinnin ja metsätalous liitännä
sinäkemien avulla. Eläkevaihtoehdossa metsäomist
ata on passiivinen pääomamarkkinoiden ja eläkkeenä

Vähimmäismäärävastuun muutosta tarkastellaan seu
raavien päätöstilanteen tekijöiden vaihtelun suhteen
— metsäon pinta-ala
— metsäon puusto
— metsäon metsänhoidon taso
— liitännäsinäkemien pääomakanta
— kantohtinta
— pääomamarkkinoiden korko
— eläke
— liitännäsinäkemien pääomakannan määritystä.

Metsäon pinta-ala ja liitännäsinäkemien pääoma
kannan muutoksen suhteen vähimmäismäärävastuun muutos on riippuvainen metsäomistajan taloudellis
eta tilanteesta. Puuston ja metsänhoidon tason suhteen
vähimmäismäärävastuun on positiivisesti riippuvuus

Enimmäismäärävastuun ominaisuuksia tarkastellaan vertaialta, jossa jatkakko eläkevaihtoehot ovat
— metsäon pinta-ala
— metsäon puusto
— metsäon metsänhoidon taso
— metsäon verotettava tulo pinta-alayksikköä kohti
— liitännäsinäkemien pääomakanta
— kantohtinta
— aikapreferenssin astes
— pääomamarkkinoiden korko

Pinta-ala suhteen tarkasteltu voidaan muuntaa oston kohteen olevan metsäon pinta-ala suhteen määritte
nytin margaalihyyden ja keskimääräisen hiiliny hyvän ni

Y = metsäon yksikkokohd (m^2/0,1 ha)
X1 = kaupan kokonainpinta-ala (0,1 ha)
X2 = metsäpinta-ala ja kokonainpinta-ala suhde (suhdeluku)
X3 = keskiakas (m^2/ha/a)
X4 = metsäon etäisyys lähimmän taajamaan (km)
X5 = ostajan status (maitovajaellja tai muu yksityinen = 1, muut = 0)
X6 = lainarahaitos pinta-alayksikköä kohti (m/k/0,1 ha)
X7 = hakuututorahoitospinta-alayksikköä korro (m/k/0,1 ha)
X8 = tukkipuisto pinta-alayksikköä korro (m^2/0,1 ha)
X9 = metsänhoitoottotarve (m/k/ha)
X10 = metsäon sijaintilääni (Hämeen lääni tai Kymen lääni tai Mikkeli lääni = 1, muut lääni = 0)
X11 = metsäon sijaintikunnan kunnalliseurottavan per capita-tulo kehitys (vuosien 1983 ja 1980 tulojen suhdeluku)
X12 = metsäerottukseksi keskiarvon (0,1 m^2/ha/a)
X13 = rantaviivan pituus (m/m,01 ha/)

Tutkimuksessa tarkastellaan yhtenä suhteen kauppan

F 147,3 157,7 159,5 177,8
vapaus
asteet 423 423 423 423

Y = metsäon yksikkokohd (m^2/0,1 ha)
X1 = kaupan kokonainpinta-ala (0,1 ha)
X2 = metsäpinta-ala ja kokonainpinta-ala suhde (suhdeluku)
X3 = keskiakas (m^2/ha/a)
X4 = metsäon etäisyys lähimmän taajamaan (km)
X5 = ostajan status (maitovajaellja tai muu yksityinen = 1, muut = 0)
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X9 = metsänhoitoottotarve (m/k/ha)
X10 = metsäon sijaintilääni (Hämeen lääni tai Kymen lääni tai Mikkeli lääni = 1, muut lääni = 0)
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X12 = metsäerottukseksi keskiarvon (0,1 m^2/ha/a)
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vapaus
asteet 423 423 423 423

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X2 = metsäpinta-ala ja kokonainpinta-ala suhde (suhdeluku)
X3 = keskiakas (m^2/ha/a)
X4 = metsäon etäisyys lähimmän taajamaan (km)
X5 = ostajan status (maitovajaellja tai muu yksityinen = 1, muut = 0)
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X8 = tukkipuisto pinta-alayksikköä korro (m^2/0,1 ha)
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X10 = metsäon sijaintilääni (Hämeen lääni tai Kymen lääni tai Mikkeli lääni = 1, muut lääni = 0)
X11 = metsäon sijaintikunnan kunnalliseurottavan per capita-tulo kehitys (vuosien 1983 ja 1980 tulojen suhdeluku)
X12 = metsäerottukseksi keskiarvon (0,1 m^2/ha/a)
X13 = rantaviivan pituus (m/m,01 ha/)

Tutkimuksessa tarkastellaan yhtenä suhteen kauppan

F 147,3 157,7 159,5 177,8
vapaus
asteet 423 423 423 423
Appendix: Description of the variables and estimation results

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List of variables of the empirical study
Table 1. Box-and-Whisker Plots
Table 2. Draftsman Plot
Table 3. Correlation Coefficient Matrix
Table 4. Regression Analysis Results
   — model fittings
   — analysis of variables
   — plots of residuals
Table 4.1. Selling price
Table 4.2. Purchasing price
Table 4.3. Transaction price
Table 4.4. Square root of transaction price

List of variables
Y  = unit price of the woodlot (FIM/0.1 ha)
X1 = total area of the transaction (0.1 ha)
X2 = ratio of forest area to total area (relative figure)
X3 = mean increment (0.1 m³/ha/a)
X4 = distance from woodlot to nearest densely populated area (km)
X5 = buyer’s status (farmer or other private person = 1, others = 0)
X6 = loan finance per unit area (FIM/0.1 ha)
X7 = cutting revenue finance per unit area (FIM/0.1 ha)
X8 = sawtimber per unit area (m³/0.1 ha)
X9 = need for silvicultural work (FIM/ha)
X10 = woodlot’s location county (Häme or Kymi or Mikkeli = 1, other counties = 0)
X11 = development of locally taxed per-capita income in woodlot’s location municipality (income ratios for 1983 and 1988)
X12 = mean forest taxation site quality (0.1 m³/ha/a)
X13 = length of shoreline (m/0.1 ha)

Appendix table 1. Box-and-Whisker Plots
Explanation (STSC 1988):
The height of the box covers the middle 50% of the data values between the lower and upper quartile.
The central line of the box is at the median.
The notch of the box corresponds to the width of a confidence interval at 95% level for the median.
The width of the box is proportional to the square root of the number of observations.
The whiskers extend out to the extremes in case they are within 1.5 times the interquartile range.
The unusual values outside 1.5 times the interquartile range are plotted as separate points.
Appendix table 1b. Box-and-Whisker Plots of variables X4, X5, X6 and X7.

Appendix table 1c. Box-and-Whisker Plots of variables X8, X9, X10 and X11.

Appendix table 2. Draftsman Plot (pairwise scatter diagrams for all combinations of variables).
Appendix table 4. Regression analysis results

Table 4.1. Selling price

<table>
<thead>
<tr>
<th>Model fitting results for: Y²</th>
<th>coefficient</th>
<th>std. error</th>
<th>t-value</th>
<th>sig. level</th>
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<tr>
<td>CONSTANT</td>
<td>-261.19267</td>
<td>114.79671</td>
<td>-2.2753</td>
<td>0.0234</td>
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<tr>
<td>1/X1</td>
<td>18173.25742</td>
<td>4485.40178</td>
<td>4.05116</td>
<td>0.0001</td>
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<tr>
<td>X3</td>
<td>6.150286</td>
<td>0.879267</td>
<td>6.9948</td>
<td>0.0000</td>
</tr>
<tr>
<td>1/X4</td>
<td>294.4560914</td>
<td>83.191139</td>
<td>3.5462</td>
<td>0.0006</td>
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<tr>
<td>X8</td>
<td>84.447966</td>
<td>4.254082</td>
<td>19.8510</td>
<td>0.0000</td>
</tr>
<tr>
<td>X10</td>
<td>209.870502</td>
<td>27.563405</td>
<td>7.6141</td>
<td>0.0000</td>
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<tr>
<td>X11</td>
<td>249.235474</td>
<td>74.330218</td>
<td>3.3531</td>
<td>0.0009</td>
</tr>
<tr>
<td>X12</td>
<td>-1.23771</td>
<td>1.60539</td>
<td>-0.7707</td>
<td>0.4413</td>
</tr>
<tr>
<td>X13</td>
<td>9.381724</td>
<td>11.413389</td>
<td>0.8149</td>
<td>0.4156</td>
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</tbody>
</table>

R-SQ (ADJ.) = 0.7308 SE = 230.539397 MAE = 159.805305
432 observations fitted, forecast (s) computed for 0 missing val. of dep. var.

Analysis of Variance for the Full Regression

<table>
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<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F-Ratio</th>
<th>P-value</th>
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<td>7865277.2</td>
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<td>Error</td>
<td>22481779.6</td>
<td>423</td>
<td>5314.84</td>
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<tr>
<td>Total (Corr.)</td>
<td>85120958.6</td>
<td>431</td>
<td></td>
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<tr>
<td>R-squared</td>
<td>0.735832</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
R-squared (Adj. for d.f.) = 0.730835

Residual Plot for Y²
### Appendix table 4. Regression analysis results

#### Table 4.2. Purchasing price

Model fitting results for: $Y^d$

<table>
<thead>
<tr>
<th>Indep. variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-value</th>
<th>Sig. level</th>
</tr>
</thead>
<tbody>
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<td>-4.0942</td>
<td>0.0001</td>
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<tr>
<td>1/X1</td>
<td>40035.5457</td>
<td>5318.985127</td>
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</tr>
<tr>
<td>X2</td>
<td>475.75178</td>
<td>87.494277</td>
<td>5.3475</td>
<td>0.0000</td>
</tr>
<tr>
<td>X6</td>
<td>0.907193</td>
<td>0.125828</td>
<td>7.2461</td>
<td>0.0000</td>
</tr>
<tr>
<td>X7</td>
<td>-2.661335</td>
<td>0.332576</td>
<td>-8.0022</td>
<td>0.0000</td>
</tr>
<tr>
<td>X8</td>
<td>150.550206</td>
<td>8.195442</td>
<td>18.3760</td>
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</tr>
<tr>
<td>X9</td>
<td>-0.238876</td>
<td>0.03749</td>
<td>-6.3717</td>
<td>0.0000</td>
</tr>
<tr>
<td>X10</td>
<td>172.594451</td>
<td>27.372078</td>
<td>6.3055</td>
<td>0.0000</td>
</tr>
<tr>
<td>X12</td>
<td>-1.125639</td>
<td>1.333523</td>
<td>-0.8740</td>
<td>0.4633</td>
</tr>
</tbody>
</table>

R-SQ (Adj.) = 0.7441  SE = 224.77664  MAE = 154.562795

432 observations fitted, forecast (s) computed for 0 missing val. of dep. var.

#### Analysis of Variance for the Full Regression

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F-Ratio</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>63722078</td>
<td>8</td>
<td>7966510.2</td>
<td>157.676</td>
<td>.0000</td>
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<tr>
<td>Error</td>
<td>21371880</td>
<td>423</td>
<td>50254.5</td>
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</tr>
<tr>
<td>Total (Corr.)</td>
<td>85103958</td>
<td>431</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

R-squared = 0.748873  Std. error of est. = 224.777

R-squared (Adj. for d.f.) = 0.744124

---

### Appendix table 4. Regression analysis results

#### Table 4.3. Transaction price

Model fitting results for: $Y$

<table>
<thead>
<tr>
<th>Indep. variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-value</th>
<th>Sig. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONSTANT</td>
<td>-476.77458</td>
<td>117.564968</td>
<td>-4.0575</td>
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<tr>
<td>1/X1</td>
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<td>0.0002</td>
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<td>370.21887</td>
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</tr>
<tr>
<td>X3</td>
<td>5.11013</td>
<td>0.810725</td>
<td>6.3032</td>
<td>0.0000</td>
</tr>
<tr>
<td>1/X4</td>
<td>277.89368</td>
<td>82.164928</td>
<td>3.3821</td>
<td>0.0008</td>
</tr>
<tr>
<td>X5</td>
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<td>27.274864</td>
<td>-3.2435</td>
<td>0.0013</td>
</tr>
<tr>
<td>X6</td>
<td>85.04621</td>
<td>4.165379</td>
<td>20.7158</td>
<td>0.0000</td>
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<tr>
<td>X10</td>
<td>184.93783</td>
<td>26.290506</td>
<td>7.0321</td>
<td>0.0000</td>
</tr>
<tr>
<td>X11</td>
<td>202.56260</td>
<td>72.339026</td>
<td>2.7994</td>
<td>0.0054</td>
</tr>
</tbody>
</table>

R-SQ (Adj.) = 0.7463  SE = 223.802666  MAE = 154.181376

432 observations fitted, forecast (s) computed for 0 missing val. of dep. var.

#### Analysis of Variance for the Full Regression

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F-Ratio</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
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<td>798961.1</td>
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<tr>
<td>Error</td>
<td>21187073</td>
<td>423</td>
<td>50087.6</td>
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<tr>
<td>Total (Corr.)</td>
<td>85103958</td>
<td>431</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

R-squared = 0.751045  Std. error of est. = 223.803

R-squared (Adj. for d.f.) = 0.746336

---

### Residual Plot for $Y^d$

-2 0 2 3 5 7 9 10 15 20

---

### Residual Plot for $Y$

-2 0 2 3 5 7 9 10 15 20

---

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Appendix table 4. Regression analysis results

Table 4.4. Square root of transaction price

<table>
<thead>
<tr>
<th>Model fitting results for: $\sqrt{V}$</th>
<th>coefficient</th>
<th>std. error</th>
<th>t-value</th>
<th>sig. level</th>
</tr>
</thead>
<tbody>
<tr>
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<td>-2.212536</td>
<td>2.077539</td>
<td>-1.0650</td>
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<tr>
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<tr>
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</tr>
<tr>
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</tr>
<tr>
<td>1/X4</td>
<td>4.957324</td>
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</tr>
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<td>X5</td>
<td>-1.289972</td>
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<td>0.0078</td>
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<td>X8</td>
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<td>0.072585</td>
<td>19.4421</td>
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<td>X10</td>
<td>3.455813</td>
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<td>X11</td>
<td>4.324058</td>
<td>1.793199</td>
<td>3.3790</td>
<td>0.0008</td>
</tr>
</tbody>
</table>

R-SQ. (ADJ.) = 0.7664  SE = 3.956929  MAE = 2.990282  432 observations fitted, forecast (s) computed for 0 missing val. of dep. var.

Analysis of Variance for the Full Regression

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F-Ratio</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>22270.0</td>
<td>8</td>
<td>2783.76</td>
<td>177.73</td>
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<tr>
<td>Error</td>
<td>6623.0</td>
<td>423</td>
<td>15.6573</td>
<td></td>
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</tr>
<tr>
<td>Total (Corr.)</td>
<td>28893.1</td>
<td>431</td>
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<td></td>
</tr>
<tr>
<td>R-squared = 0.770774</td>
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<td>Std. error of est. = 3.95693</td>
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</tr>
<tr>
<td>R-squared (Adj. for d.f.) = 0.766439</td>
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<td></td>
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</tr>
</tbody>
</table>

Residual Plot for $\sqrt{V}$

Instructions to authors — Ohjeita kirjoittajille

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The editor-in-chief will forward the manuscript to referees for examination. The author must take into account any revision suggested by the referees or the editorial board. Revision should be made within a year from the return of the manuscript. If the editor finds the suggested changes unacceptable, he can inform the editor-in-chief of his differing opinion, so that the matter may be reconsidered if necessary.

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Käsikirjoituskirjasto

214 Luangjame, Jesada. Salinity effects in Eucalyptus camaldulensis and Combretum quadrangulare: ecophysiological and morphological studies. Tiivistelmä: Suolaisuuden vaikutukset Eucalyptus camaldu-
 lensikseen ja Combretum quadrangulareen: eko-
fysiologisia ja morfologisia tutkimuksia.


