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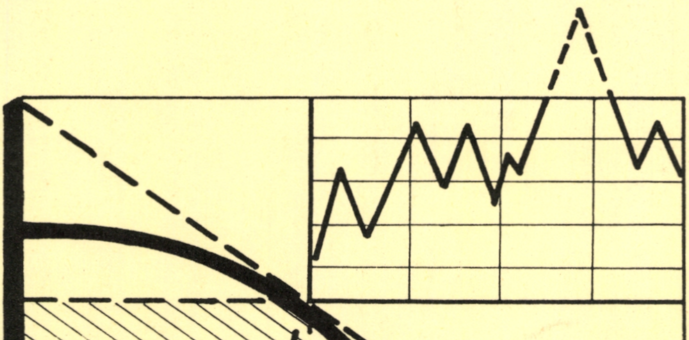
ON PRICE ADJUSTMENT IN THE SAWLOG AND SAWNWOOD EXPORT MARKETS OF THE FINNISH SAWMILL INDUSTRY

Vesa Kanniainen and Jari Kuuluvainen



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The present paper examines price adjustment in the sawlog and sawnwood export markets of the Finnish sawmill industry. Initially a simple portfolio model for the private nonindustrial forest owner is presented. The implication of the model is that because of the importance of the capital gain on the rate of return on the woodlot, the presently held price expectations are an important determinant of the forest owners' willingness to supply sawlogs from current inventories. Intertemporal speculation may therefore greatly influence the price dynamics in the sawlog market.

Randomness of prices is an indication of their speed of adjustment to "news" or unanticipated shocks concerning the market. If the market is perfectly price flexible prices are generated by a random walk process. The empirical part of the study analyses the randomness of the sawlog stumpage prices using time series analysis and econometric methods. For comparison similar tests are carried for sawnwood export prices.

Autocorrelation and partial autocorrelation tests indicate that the sawlog market is of a flex-price nature, at least on the semiannual basis. However, the regression tests do give somewhat contradictory results by showing that, specially in case of real prices, it is possible to find exogenous variables other than the lagged price which have a statistically significant effect on the present stumpage price.

For sawnwood export prices the results are unambiguous. Both autocorrelation and partial autocorrelation tests and regression tests indicate rigid price adjustment. The tentative conclusion is that price adjustment during the study period (1960-1981) has been faster in sawlog market than in sawnwood export markets. The behaviour in the sawlog market therefore depends, to great extent, on the asset motive. Conversely, in export sawnwood markets, prices are very much influenced by the current flow demand and the flow supply of sawnwood.

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CONTENTS

1. INTRODUCTION

Significant cyclical changes in the deliveries of sawlogs associated with highly fluctuating stumpage prices have been the dominant feature of the sawlog market in Finland. The fluctuations in stumpage prices seem to exceed the changes which can be linked to variations in sawnwood demand and sawnwood export prices. Since a more stable and predictable stumpage price development would, in the long run, benefit both the suppliers of sawlogs and the sawmill industry, efforts have been made to even out these fluctuations. Actions to stabilize these short-run price fluctuations in the roundwood markets have led to an agreement system between the Forestry Council of the Central Union of Agricultural Producers[1)] and the Central Association of Finnish Forest Industries.[2)] Since 1964 there have been negotiations of the general recommended price for pulpwood and for veneer logs (although not for every felling season). However, the first agreement for sawlog prices for the country as a whole did not succeed before the felling season 1978/79. The earlier agreements have been regional.

In spite of the agreement process outlined above, stumpage prices have been more random than one would expect, and this is the problem on which our paper will focus. Price behaviour and price formation in the sawlog market is interesting because it provides information on the nature of

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1) Maataloustuottajain Keskusliiton Metsävaltuuskunta.
2) Metsäteollisuuden Keskusliitto.

the market processes and market forces in this field of great importance for the Finnish economy. The role of the stocks carried by the agents of this market, the expectation mechanisms, etc., are related problems. One can also raise the question as to what extent there are possibilities to forecast the short-run price development in the sawlog market. Our study gives some light to this problem, too.

We will organize the paper as follows. In chapter 2, we present a portfolio model for the forest owner, which gives an insight into the dependence of present prices and future expectations. In chapter 3, tests revealing the nature of sawlog stumpage price formation are presented. As a reference, chapter 4 presents similar tests using export unit value of sawnwood. Discussion follows in chapter 5.

2. PORTFOLIO MODEL FOR THE FOREST OWNER

The market for sawlogs is a market for a storable and highly durable commodity. A stock of sawlogs is an asset to the owner in his wealth portfolio. Sawlogs are used as raw material mainly by the sawmill industry. The annual increment in the aggregate standing stock of sawlogs is small relative to the existing stock. Similarly, the annual "consumption" of the stock is small relative to the stock. Hence, the current market value (price) of sawlogs depends on the willingness of the market participants to hold this commodity in their stocks. As in the case of all durable goods, the supply of sawlogs out of stock is sensitive to price changes. Actually, if the price expectations are such that the anticipated appreciation of the price of sawlogs is sufficient to counter the interest (and storage) costs, the owner would presumably deter from selling from his stock. The demand for additions to stocks held by the industry, will be based on the expectation that prices in the future periods may be sufficiently high to motivate the addition now in spite of the interest and storage costs accrued.

To study the effects of price expectations on current price in the market for sawlogs, denote the current value of a unit of timber as V_t. (For simplicity, we ignore the value of the bare land and production costs of timber. Therefore our model only considers the asset feature of the standing stock in short term.) The equilibrium condition for a private non-industrial forest-owner can be written as an equality between the expected returns in the after-tax sense. Algebraically,

$$(2.1) \qquad \left[E_t(V_{t+1}) - V_t\right] - \tau_f V_t = (1-\tau) r V_t, \text{ where}$$

V = value of the woodlot

τ_f = tax rate on woodlot

τ = tax rate on interest income

r = rate of return on alternative assets

$E_t(V_{t+1})$ = the expectation of the next period's value of woodlot, formed in the current period

The equilibrium condition dictates that the current value of a unit of woodlot will adjust so as to maintain an equality between the expected after-tax rate of return on woodlot and the rate of return on other assets.[1)] In this framework, the latter consists only of the expected capital gain, while the influence of the physical growth of the stock is ignored here. Solving for V_t gives

$$(2.2) \qquad V_t = \left[E_t(V_{t+1})\right] / \left[1 + (1-\tau)r + \tau_f\right].$$

Any "news" or unanticipated shocks in the timber market which have a impact on currently held expectations of the future value of the timber lot will change the current valuation of the sawlogs in the inventories. However, due to discounting effect, the current valuation will change less than the expected future valuation because

$$(2.3) \qquad \partial V_t / \partial E_t(V_{t+1}) < 1.$$

Note from (2.2) that forest taxation tends to increase the discounting effect while the tax on the opportunity cost tends to dampen it. Finally, note from (2.2) that any increase in the opportunity cost rate r will immediately reduce the current valuation of the woodlot.

While (2.2) is useful for the assessment of the effects of

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1) For simplicity, we assume that tax on a woodlot depends on the money value of the standing trees. The tax free recently regenerated clear cut areas bring some realism to the assumption in the Finnish case.

news, i.e. unanticipated shocks to the demand for or supply of sawlogs, it is useful to have a look at the valuation of sawlogs in a world without shocks. In this case, perfect foresight (sometimes called "rational expectations") holds and the expected value of woodlot in (2.1) can be replaced by the actual value. This leads to a homogenous first-order difference equation

$$(2.4) \qquad V_t - \left[1 + \tau_f + (1 - \tau)r\right] V_{t-1} = 0.$$

Its solution reads as

$$(2.5) \qquad V_t = V_0(1 + \varphi)^t,$$

where φ is the required, pre-tax rate of return on woodlot, i.e.

$$(2.6) \qquad \varphi = \tau_f + (1 - \tau)r.$$

Along the equilibrium path of the value of woodlot, the capital gain satisfies

$$(2.7) \qquad (V_t - V_{t-1})/V_{t-1} = \varphi.$$

In the absence of any taxes on capital income or property, the capital gain equals the market rate of interest r.

The above discussion suggests that, in the absence of shocks i.e. unanticipated changes in underlying demand and supply conditions, in capital markets or in taxes, the value of sawlogs would evolve in a very predictable manner. On the other hand, given that the market for sawlogs is continuously subject to shocks, one can expect that the prices are quite flexible, even in the short run, unless there are institutional factors which dampen down price fluctuations. Since the capital gain is the dominant element in the rate of return on the woodlot, the currently held expectation of future prices are a crucial determinant of the willingness to supply sawlogs from current inventories. Finally, given the importance of the expectational elements in the sawlog market, it is possible that an intertemporal speculation greatly influences the price dynamics in this market.

The above remarks raise the need for an empirical analysis of the sawlog stumpage price formation. The question which urgently needs an answer is whether prices in the market for sawlogs are flexible enough to justify the above view of intertemporal speculation. It is to this problem we devote the rest of the paper. Time-series and econometric methods are employed.[1)] In order to demonstrate that our empirical tests actually lead to different conclusions in different markets, we also report the results of a similar analysis in the case of sawnwood export markets.

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1) Looking at the problem yet from another perspective, the question is whether the market for sawlogs is a "flex-price" or "fix-price" market in the hicksian sense. Actually, the empirical test we plan to undertake are those used to study "market efficiency" i.e. randomness of prices, see Samuelson (1965 and 1973). In the Finnish research tradition, the importance of stumpage price expectations was first explicitely pointed out by Korpinen (1980) but one can also refer to Ollonqvist (1981). The capital market approach was found useful by Olsen and Terpstra (1981) who applied capital asset pricing model to softwood logs.

3. EMPIRICAL ANALYSIS OF SAWLOG SUMPAGE PRICES

3.1. Time-series analysis

Full flexibility of prices in the market for sawlogs would imply that the market price is a "jump variable" in the sense that it will respond to shocks and news without a lag while being constant (or governed by a deterministic drift) in the absence of shocks. This null-hypothesis of a random walk process can be tested using autocorrelation and partial autocorrelation functions. Semiannual data for 1960 - 1981 on nominal stumpage prices of sawlogs in Finland were introduced by Kuuluvainen (1984) and this data set will be submitted for time-series analysis below. These data are based on a sample of one hundred communes from the basic data of forest taxation. Official statistics have, until 1979, only produced yearly price observations (and no data concerning sales). To obtain the semiannual observations employed here, a sampling method was used in order to economize on computation resources and time (Kuuluvainen 1984, p. 122).

Figure 1 reports the estimated autocorrelation and partial autocorrelation functions for nominal sawlog prices for lags 1-8. The autocorrelation function decays quite slowly suggesting that the price series is either a random walk process or an autoregressive (AR) process. The first correlation coefficient both in autocorrelation and partial autocorrelation functions is high, i.e. 0.89, while partial autocorrelation function has a clear cut-off at lag one. Hence, if the data come from a stationary autoregressive process it will be of the first order. To judge whether the data actually come from a stationary or non-stationary process, autocorrelation and partial autocorrelation function were formed for the differenced price variable.

The autocorrelation function of the differenced time series has peaks at lags 3 and 6 but they are not statistically significant (they are within the limits of two standard errors) and there is no economic interpretation for a process which would generate that type of time-series pattern.[1] Autocorrelation and partial autocorrelation functions of real prices (appendix 1, figures A1 and A2) behave very much in the same way as those of nominal prices. The only difference is that the peaks at lag 3 in the autocorrelation and partial autocorrelation functions of the first differences are statistically significant. Their interpretation, however, is equally difficult. Consequently, they can safely be regarded as due to the randomness of the estimates. Other coefficients in autocorrelation and partial autocorrelation functions of the differenced series are very small. Hence, on the basis of the available semiannual data set, we are not able to reject the hypothesis that the differenced price series is a white noise process. Consequently, we are not able to turn down the view that the nominal prices are a random walk. This means that if q_t denotes the semiannual stumpage price no ARIMA-model can beat the predictive power of a simple random walk model such as

$$(3.1) \qquad q_t = q_{t-1} + a_t$$

where a_t is a white noise process.

The results just obtained are important and seem to indicate that the stumpage market is of a flex-price nature, at least on a semiannual basis. To check the conclusion, we formed logarithmic transformations of the price series to reduce the heteroscedasticity of the price series. The results are not reported here as they gave no reason to change the above conclusion.

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1) These peaks do not indicate persistency or seasonality in any meaningfull way.

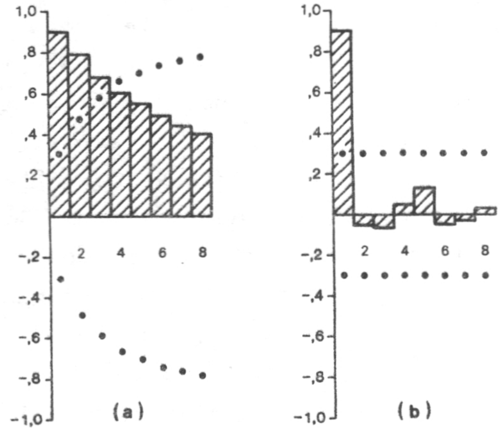

Figure 1. Autocorrelation (a) and partial autocorrelation (b) functions of sawlog stumpage prices, semiannual observations from 1960/1 to 1981/1, levels.

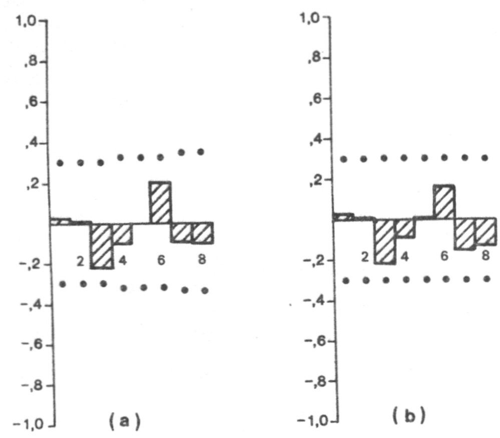

Figure 2. Autocorrelation (a) and partial autocorrelation (b) functions of the first differences of semiannual sawlog stumpage prices from 1960/1 to 1981/1.

It is of interest to explore whether the random walk nature of sawlog prices can be extended to data with a shorter observation period. Such an exploration is actually facilitated by the monthly observations which are available for 1975-1982.[1] This period also includes general recommended price agreements for sawlog prices during the felling seasons 1978/79 and 1980/81 to 1982/83.

In figures 3 and 4 we report the estimates for autocorrelation and partial autocorrelation functions of monthly sawlog prices. We study both the original time series and the first differences. The autocorrelation function decays very slowly starting with a coefficient 0.96 at lag one. Again, the partial autocorrelation function has a cut-off at lag one, although the coefficient at lag two, which is negative, is quite high. Before trying to arrive at any final conclusions, we look into the first differences of monthly prices. The coefficients in the autocorrelation and partial autocorrelation functions at lag one are 0.21 and therefore "almost" significant using standard criteria. Hence, we try to fit an autoregressive model of the first order in first differences of prices i.e.

(3.2) $$(1 - \phi B)\, \Delta q_t = a_t$$

where $\Delta = 1 - B$, B is a lag operator, $B^j q_t = q_{t-j}$ and a_t is again a white noise process. The result is

(3.3) $$\Delta q_t = \underset{(2.48)}{0.38}\, \Delta q_{t-1} + \hat{a}_t,$$

where the t-value associated with the autoregressive coefficient is presented in parenthesis. The equation (3.3) can be rewritten in a more illustrative form

(3.4) $$q_t = q_{t-1} + 0.38(q_{t-1} - q_{t-2}) + \hat{a}_t.$$

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1) The Central Association of the Finnish Forest Industries

The autocorrelation and partial autocorrelation functions of the empirical residuals $\hat{a}_t$ do not indicate autocorrelation, although at lag 12 both have "almost" significant peaks. These peaks can also be seen in figure 4, and they refer to the potential seasonality in price observations, although it is not very strong. In any case, the portmanteau Q statistic, calculated for 24 lags, obtained the value 13 which is much below 35, the critical value at 5 % risk level.

There is a systematic difference between monthly and semiannual price observations. While a random walk specification for the latter could not be rejected, the former indicates persistency. Hence, there are frictions in the price mechanism in the market for sawlogs which prevent full and immediate adjustment of prices. These may be due to costs of acquiring information about changed market conditions or they may simply result from the price recommendations if market participants expect that those recommendations are unbiased predictors of actual future prices.

3.2. Regression models for sawlog stumpage prices

Autocorrelation and partial autocorrelation functions presented in the previous section did not falsify our hypothesis concerning the random walk nature of semiannual sawlog prices. An economic interpretation of this is that prices are flexible and that they reflect the future expectations of the agents in the markets. This means that semiannual prices are continuously at "intrinsic" levels with respect to future expectations. Theoretically, in this case, all information needed to forecast future prices is contained in the present price, as already demonstrated in equation (3.1). Therefore, in forecasting the price in the next period, only the previous price q_{t-1} is required as the explanatory variable because

(3.5) $E(q_t | X, q_{t-1}, q_{t-2} \ldots) = E(q_t | q_{t-1})$.

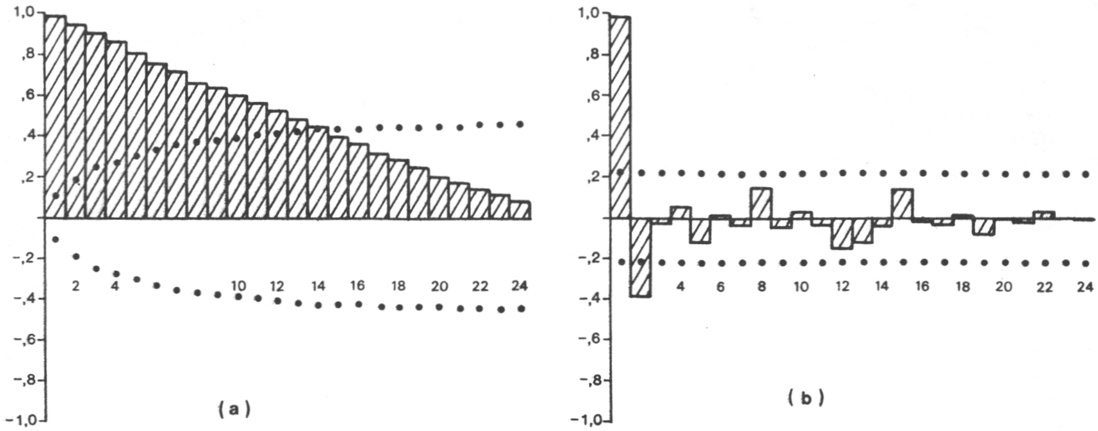

Figure 3. Autocorrelation (a) and partial autocorrelation (b) functions for monthly nominal sawlog prices in 1967/7 - 1982/6 for lags 1-24, levels.

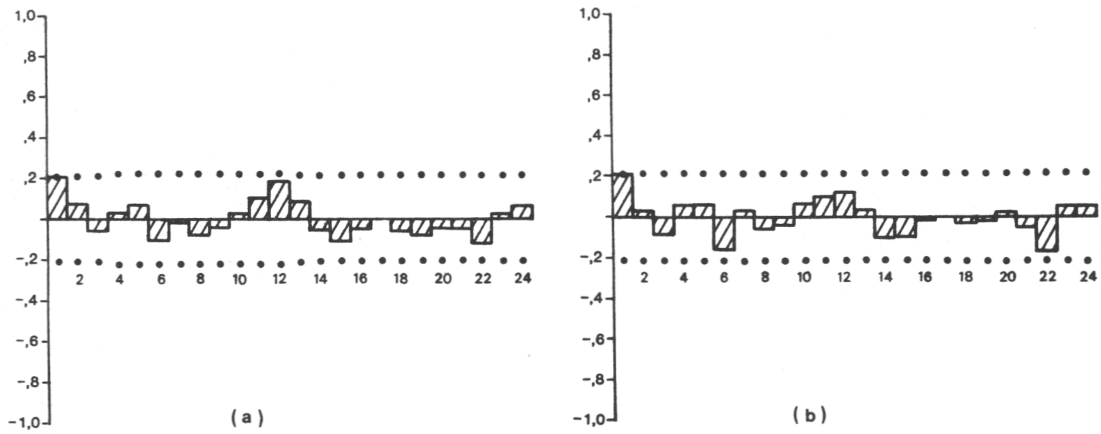

Figure 4. Autocorrelation (a) and partial autocorrelation (b) functions for first differences of monthly nominal sawlog stumpage prices from 1967/7 to 1982/6 for lags 1 - 12.

Other potential explanatory variables (X) in no way help to predict the price, q_t. This does not rule out the possibility that q_t is correlated with other variables relevant to the market system. The implication, however, is that such variables are of no help in predicting the value of the future price, if the present price is included in the list of independent variables. Consider a regression model

(3.6) $$q_t = \gamma_0 + \sum_{i=1}^{n} \gamma_i q_{t-i} + \beta X + e_t,$$

where q - stumpage price
γ_0 - constant
γ_i - coefficients of lagged stumpage prices
X - vector of current and lagged exogenous variables
β - coefficients of exogenous variables
e - error term

If prices are fully flexible γ_1 is unity, β and γ_i are zero when $i \neq 1$ and random term e_t is white noise (cf. Sargent 1976, pp. 214-218).

Equation (3.6) gives a method (although to some extent a tentative one) to test further the flexibility of the prices Initially, we regress the present period stumpage price on its lagged value using original semiannual observations from 1962/1 to 1981/1. The estimated result is reported in table 1, column 2. A dummy variable is added to the model to take care of the step-like increase of prices in the second half of 1973. Our model therefore is actually a random walk model with a deterministic drift (cf. Granger and Newbold 1977, p. 38).

Table 1 shows that the coefficient of lagged price in this model is close to one, the constant term is very small compared to the mean of the nominal stumpage price during the study period and is statistically nonsignificant. In addition, the dummy variable is significant, indicating a random walk with deterministic drift. According to the D-W or Durbin's h- statistics, residuals do not reveal serial correlation.

When stumpage price lagged by two periods is added to the model 2 its coefficient does become statistically significant.

Table 1. Regression models for undifferenced nominal and real sawlog stumpage prices, semiannual observations from 1962 to 1981.

Independent variables	Nominal prices 1	2	Real prices 3	4
Constant	-15.26	-0.31	4.17	29.09
	(2.47)	(0.12)	(0.33)	(3.62)
q_{t-1}	0.88	1.04	0.70	0.67
	(10.95)	(30.91)	(9.32)	(8.93)
$z^e_{t,t+1}$	0.005		0.005	
	(2.88)		(3.00)	
$p^e_{t,t+1}$	0.02		-0.0005	
	(1.49)		(0.02)	
Δm_t	0.001		-0.0005	
	(0.83)		(0.77)	
$(k_t+\bar{u}_t)$	0.0008		0.002	
	(1.05)		(2.02)	
x_{t-1}	-0.001		-0.002	
	(1.52)		(2.81)	
dl	39.81	55.79	71.42	83.49
	(5.25)	(6.51)	(6.65)	(8.19)
$\bar{R}^2$	0.98	0.96	0.86	0.78
D-W	2.14	2.02	2.27	2.28
h	0.51	0.03	0.93	1.00

We now make experimental explanations of the stumpage price using variables associated with sawlog market. The exogenous variables are the reduced form variables (with the exception of the dummy variable) of the sawlog market model estimated by Kuuluvainen (1984, p. 84). The results of this test are also reported in table 1 (column 1). The variables to be added to the model are the following (for a detailed description see Kuuluvainen (op. cit, chapter 6.1):

$z^e_{t,t+1}$ - expected sawnwood demand (export sales with two period lag)

$p^e_{t,t+1}$ - expected sawnwood price (export unit value with two period lead)

q_{t-1} - lagged stumpage price

Δm_t - other than stumpage income of private nonindustrial forest owners, first differences

$(k_t+\bar{u}_t)$ - stocks of sawlogs held by the sawmilling industry at the beginning of period t, added to the consumption of raw material in production during the period.

x_{t-1} - sawlog sales from private nonindustrial forest during previous period.

dl - dummy variable (dl=1 in 1973/2, otherwise 0)

We see that now the coefficients of expected sawnwood demand ($z^e_{t,t+1}$), constant term and the dummy variable are statistically significant. In spite of this, the coefficient of determination (adjusted to degrees of freedom) only in creases from 0.96 to 0.98.

Table 1 also reports the corresponding equations for real stumpage prices (deflated by the consumer price index). The results are somewhat different compared to those obtained with current prices. When only lagged price (with constant term and the dummy variable) is used as the independent variable, the parameter estimate of its coefficient deviates from one (0.67). Also the constant term obtains an estimate which is statistically significant. Adding the reduced form variables now brings an increase in the adjusted coefficient of determination from 0.78 to 0.86.

The regression tests therefore give somewhat contradictory results compared to the autocorrelation and partial autocorrelation tests reported in section 3.1. The latter did not indicate price rigidities in the semiannual sawlog prices. However, according to the regression models it is possible to find exogenous variables, other than the lagged price, with statistically significant effects on the present price. In particular, the real price forecasts are clearly improved by adding the relevant exogenous variables to the model. The adjustment of real prices therefore seems to be 'more rigid' than the adjustment of nominal prices.

4. EMPIRICAL ANALYSIS OF SAWNWOOD EXPORT PRICES

4.1. Autocorrelations and partial autocorrelations

We use the unit value of export shippings as a proxy variable for export prices. This is necessary because the actual selling (contract) prices are only available from 1972 onwards and only for some sawnwood grades to some countries. However, disregarding the time lag between the two variables, the unit value of export shippings behaves very much in the same way as the actual contract prices (Kuuluvainen 1984, p. 70).

The autocorrelation function of prices decays more slowly than that of sawlog stumpage prices. The partial autocorrelation function has cut-off at lag 1. To obtain a stationary series, we again use first differences. The autocorrelation and partial autocorrelation functions clearly differ from those obtained when stumpage prices were used. The autocorrelation function has significant coefficients at lags 1 and 3 and also the correlation coefficient at lag two is almost significant. The function clearly oscillates. The partial autocorrelation function has a cut-off at lag two. Again, the results after logarithmic transformation remain the same and are not reported here.

4.2. Regression and ARIMA models for sawnwood prices

The autoregressive nature of the undifferenced time series of semiannual export unit value of sawnwood is indicated by the slow decay of the autocorrelation function (figure 5). Initially, therefore, an attempt to forecast present price with lagged prices using a normal regression model is made. It turns out that the best results are obtained when lags 1, 2 and 3 are used. The estimation results of this model

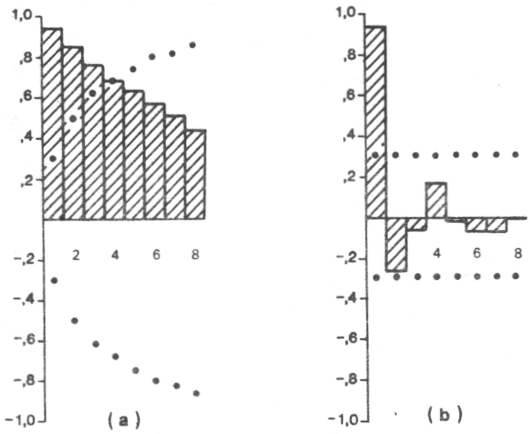

Figure 5. Autocorrelation (a) and partial autocorrelation (b) functions of semiannual nominal unit values of sawnwood export shippings from 1960/1 to 1981/1.

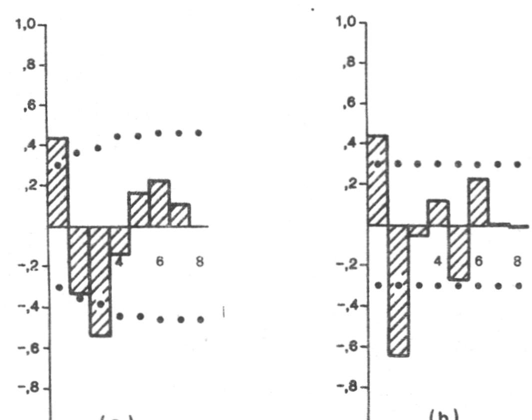

Figure 6. Autocorrelation (a) and partial autocorrelation (b) functions of first differences of semiannual nominal unit values of sawnwood export shippings from 1960/1 to 1981/1.

(t-values in parenthesis) are the following

$$(4.1)\quad p_t = \underset{(0.71)}{6.57} + \underset{(13.65)}{1.82p_{t-1}} - \underset{(6.9)}{1.61p_{t-2}} + \underset{(5.69)}{0.81p_{t-3}} + \underset{(0.85)}{26.40d1}$$

$R^2 = 0.98$, D-W=2.08

All parameter estimates of lagged prices are highly significant and the adjusted coefficient of determination is high. Autocorrelation and partial autocorrelation functions of the residuals of this model (not reported) indicated presence of autocorrelation but with no identifiable pattern (Appendix 3, figure A10).

The autocorrelation and partial autocorrelation functions refer to AR(2) process of the differenced series for nominal export unit value. The same result can also be seen from the estimated regression model above, because the following ARIMA(2,1,0) model

$$(4.2) \qquad (1 - \phi_1 B - \phi_2 B^2)(1-B)p_t = a_t$$

can be also written in the form

$$(4.3) \qquad p_t = (1+\phi_1)p_{t-1} - (\phi_1-\phi_2)p_{t-2} - \phi_2 p_{t-3} + a_t$$

This form of the model does not, however, produce satisfactory results. Adding MA parameters to the model reduces serial correlation of the residuals but correlations between the parameter estimates increase and the estimation in many cases fails to converge. It turns out that the behaviour of the model is considerably better when seasonal differences are used, although seasonal fluctuation seems to be very weak (Appendix 3, figure A10). The model is therefore estimated in the following form

$$(4.4) \qquad (1 - \phi_1 B - \phi_1 B^2)(1-B^2)p_t = w_o + (1-w_1 B)a_t$$

A constant term is added because the mean of the series is not zero. Additional MA (1) term is necessary and is probably due to the seasonal differencing. Contrary to expectations, the MA(2) term did not obtain a statistically significant parameter estimate. The estimation results of (4.4) are given below

$$(4.5) \quad (1 - \underset{(7.30)}{0.81}B + \underset{(6.80)}{0.79}B^2)(1-B^2)p_t = \underset{(3.14)}{22.05} + (1+\underset{(10.60)}{0.92}B)\hat{a}_t$$

where t-values are given under coefficients. We can also write (4.5) in standard regression form as follows

$$(4.6) \quad p_t=22.05+0.81p_{t-1}+0.21p_{t-2}-0.81p_{t-3}+0.79p_{t-4}+0.92\hat{a}_{t-1}+\hat{a}_t$$

Portmateau-Q with eight lags is 14 while the critical values at 10 % and 5 % confidence level are 13.4 and 15.5 respectively. Therefore there is some doubt as to the adequacy of the model. It also turns out that the predictive power of this model is not very good. For prediction it would be more appropriate to use monthly or quartely series and transfer function noise models with, for example, export sales as the input variable. This is however out of the scope of our paper. (Solberg (1984) has used ARIMA models to forecast sawnwood export prices of the Norwegian sawmill industry.)

The autocorrelation and partial autocorrelation tests, and the somewhat tentative experiments of modelling sawlog stumpage prices and unit value of sawnwood, show that it is possible to observe different types of price adjustments in the two markets on a semiannual basis. In the stumpage market, price adjustment seems to be fairly rapid compared with sawnwood export markets. Therefore, the behavior in the sawlog market can be viewed as resulting from the asset motive with the implication that prices tend to be quite flexible and sensitive to expectations. Conversely, in the export sawnwood markets, prices tend to be more rigid, being very much influenced by the current flow demand and the flow supply of sawnwood.

5. DISCUSSION

The results suggest that the behavior of prices in sawlog and sawnwood export markets are different. Export sawnwood markets are governed by price rigidities, whereas the sawlog market seems to be fairly close to a market with flexible prices. In the sawlog market, supply and demand in the short run have been equated the the stumpage price changes during the study period. In export sawnwood markets, for example the stocks absorb shocks instead of prices, which therefore can adjust more slowly.

The results obtained also have implications concerning the price forecasts. It is difficult to improve nominal stumpage price forecasts compared to forecasts of a simple regression model with only the lagged price as the independent variable (as we saw in chapter 2, the situation is somewhat different if real prices are considered). However, this type of model does not predict the turning points of the time series very well. For predictive purposes, the lagged endogenous variable is sometimes excluded from the equation. If this exclusion is exercised in "reduced form" equations of chapter 3, the residuals become severely autocorrelated, indicating missing variable(s). When real prices are used, the adjusted coefficient of determination decreases considerably if lagged price is not among independent variables.

In the case of the unit value of sawnwood (or actual export sales prices), it is possible to considerably increase the predictive power of the simple random walk model by using lagged prices of several preceding periods and also other explanatory variables.

The lack of observations prevents conclusions to be made concerning the effects of the recommended stumpage price agreement system for the whole country. However, it seems that the effects of the regional price agreements do not show in the semiannual aggregated time series. The weak autoregressive nature of the monthly sawlog stumpage prices may be partly due to the agreements, but it may also result from natural information delays in observing developments in the markets concerned. In any case, the agreement system drives stumpage markets towards more rigid prices so that the discrepancies between momentary supply and demand must be adjusted by other means than automatic price adjustment.

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Appendix 1.

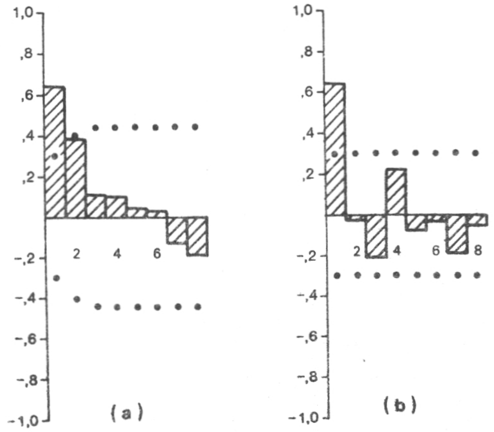

Figure A1. Autocorrelation (a) and partial autocorrelation (b) functions of real semiannual stumpage prices of saw-logs from 1960/1 to 1981/1.

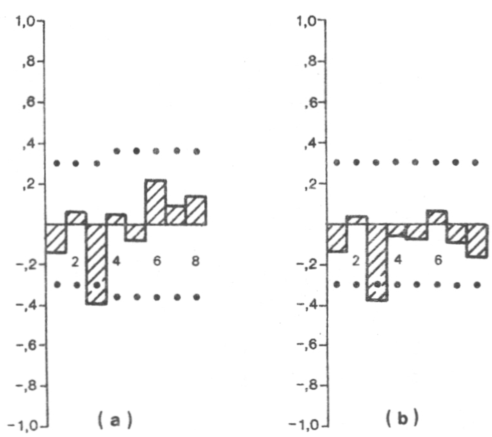

Figure A2. Autocorrelation (a) and partial autocorrelation (b) functions of first differences of real semiannual sawlog stumpage prices from 1960/1 to 1981/1.

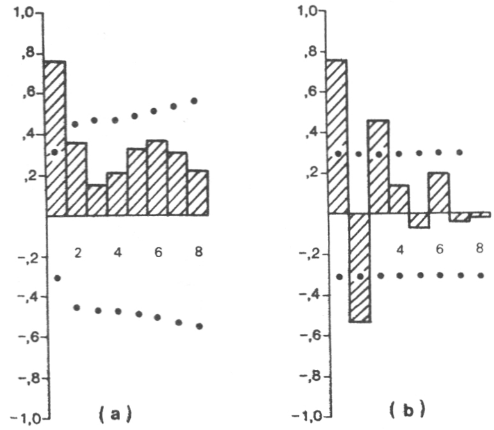

Figure A3. Autocorrelation (a) and partial autocorrelation (b) functions of real semiannual unit values of sawnwood export shippings, observations from 1960/1 to 1981/1.

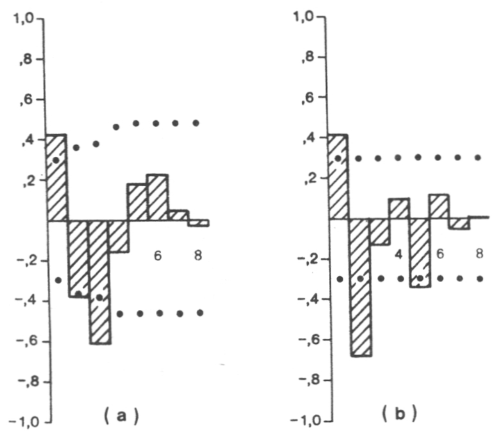

Figure A4. Autocorrelation (a) and partial autocorrelation (b) functions of first differences of real semiannual unit values of sawnwood export shippings, observations from 1960/1 to 1981/1.

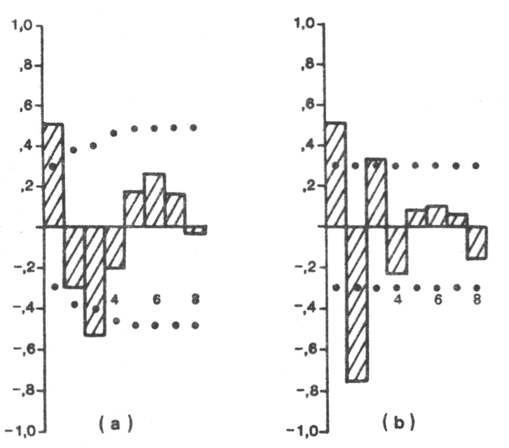

Figure A5. Autocorrelation (a) and partial autocorrelation (b) functions of seasonally differenced semiannual nominal unit values of sawnwood export shippings observations from 1960/1 to 1981/1.

Appendix 2.

Actual and fitted values of regression models in table 1.

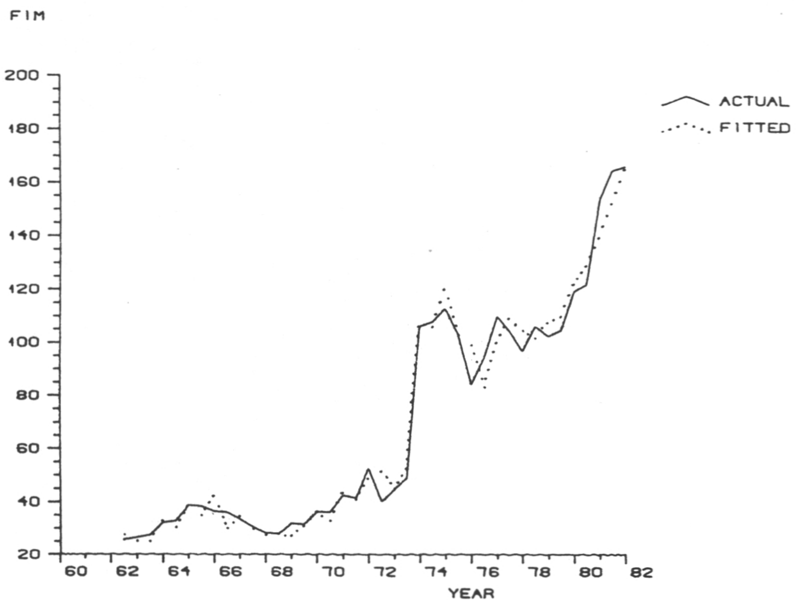

Figure A6. Model 1.

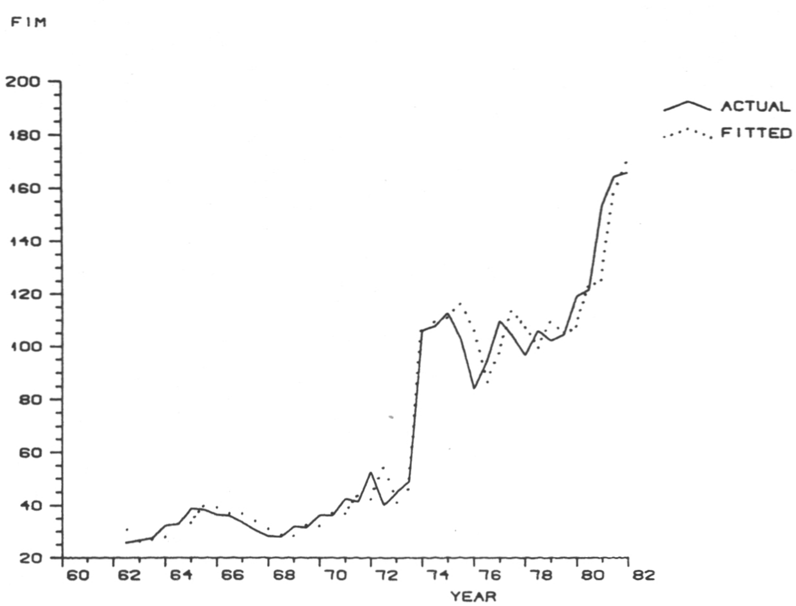

Figure A7. Model 2.

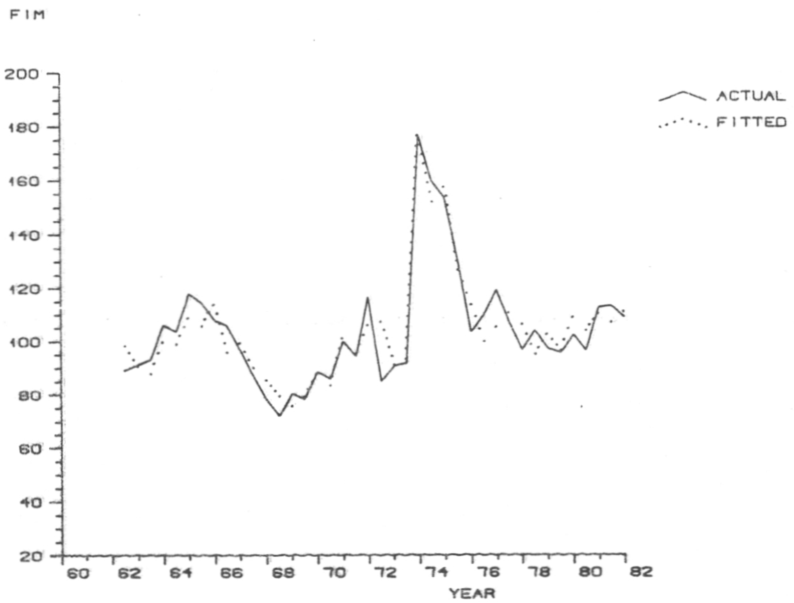

Figure A8. Model 3.

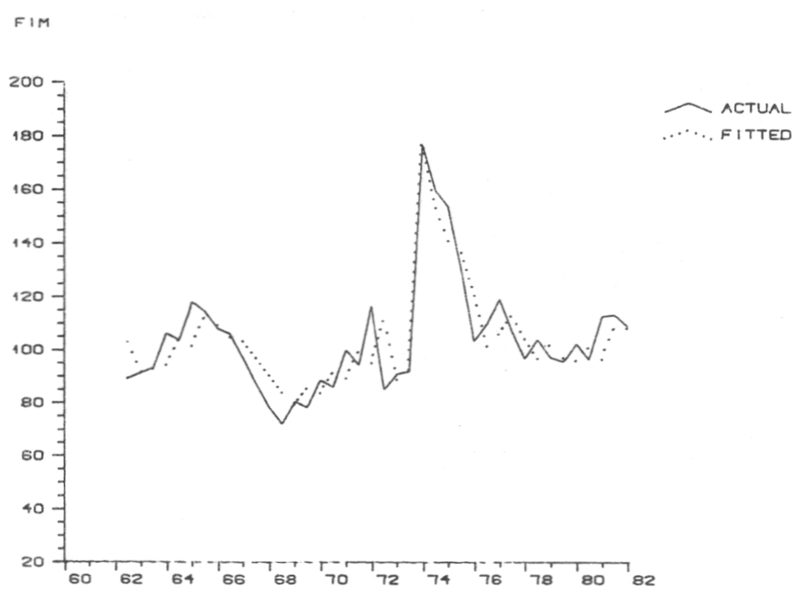

Figure A9. Model 4.

Appendix 3.

<u>Actual and fitted values of regression models for unit values of export shippings</u>

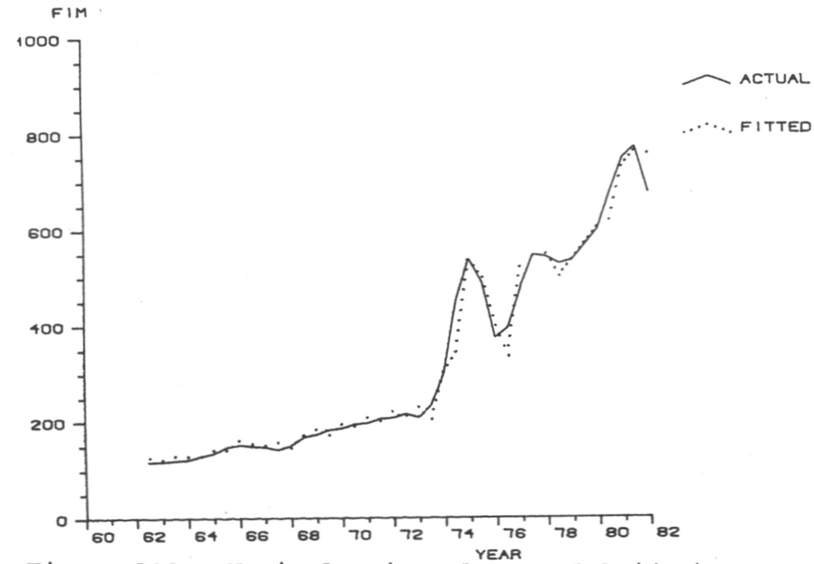

Figure A10. Nominal unit value, model (4.1).

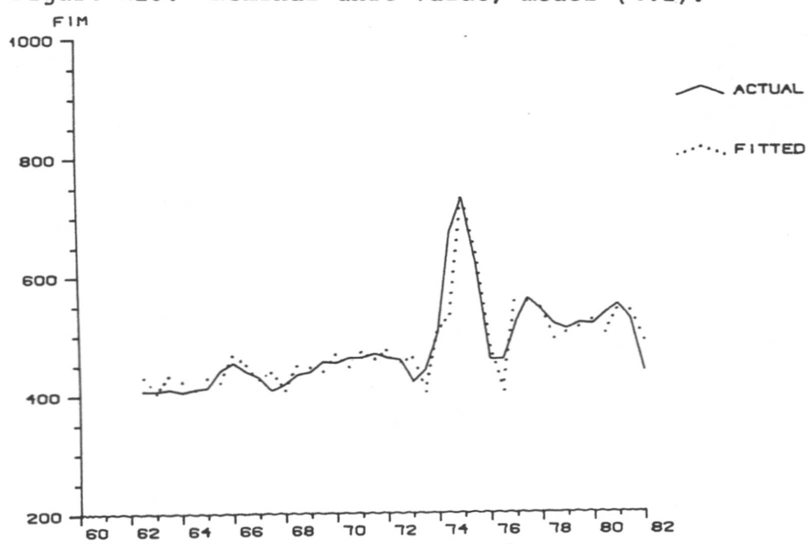

Figure A11. Real unit value, model (4.1′), below

(4.1') $P_t = 76.90 + 1.59p_{t-1} - 1.31p_{t-2} + 0.57p_{t-3} + 20.32d1$

(1.80) (11.11) (6.14) (3.99) (0.61)

$R_2 = 0.80$, D-W = 2.21

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