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Modeling long-term price development by using time-series auto-regression and expert judgments

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Abstract

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The objective of the thesis was to create a long term forecast for pine roundwood timber assortment's price in Finland for the years 2010 until 2020. The forecast's purpose was to serve as helpful information in strategic business planning of Oy Karelkon LTD throughout the next decade.

The theoretical framework for this thesis was based on quantitative forecasting theory and in particular the theory of autoregressive model of order one, or the AR1 model. This model was applied in order to achieve quantitative forecasts based on previous historical price values of pine roundwood in Finland. The model was studied and implemented to the price of product of interest synchronically. The results that were achieved were quantifiable and represented with a table as well as a visual figure.

To expand the understanding of future price development, a qualitative investigation was implemented in the form of expert interviews. Experts in the field of forestry in Finland were questioned on their opinion concerning the development of pine roundwood price throughout the next decade. Additional information was gathered concerning the forestry industry of Finland including quantitative facts.

Main variables influencing the price of timber products were established and analyzed. The current position of the timber industry outcome effects of past years were studied and analyzed.

The findings of this study are given in a form of a graph where the future development can be observed with a continuation of the previous time-series, as well as in discussion form based on the analysis of expert judgment.

The results of the quantitative forecasting techniques predicted a decline of the pine roundwood price throughout the next decade. With the application of the qualitative method that served as additional information, it was obvious that the initial AR1 forecast was somewhat too negative when concerning the second half of the decade. Several trends that affect the price development were outlined, and the general opinion of the experts was that the prices as well as the demand for the product will rise after 2015.

Key words
Time-series, autoregression, AR1 forecasting model, price, timber

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1 Introduction

The purpose of this study is to conduct a research in the area of forecasting timber commodity trading prices for the sponsor company that operates in that field. Timber prices are certainly one of the most crucial variables affecting this company's management. Forecasting future prices can be very uncertain and difficult, nevertheless this sort studies are increasingly gaining popularity in the corporate world of finance and management as they provide glimpses of future scenarios and allow managers to decrease their dependence on chance and become more scientific in dealing with their environment. In general, forecasts act as new information and management must incorporate such information into the basic objective to enhance the favorable outcome (Makridakis, Wheelright & Hyndman 1998, 16).

This study uses past price time-series analysis as the data basis on which the future time modeling is modeled. Expert knowledge and their opinions are used as additional information to enchase the time-series forecast model. Past time-series models are always the backbone of all forecasts and often can be extrapolated into the future, as well as can misguide in future predictions if not approached correctly. For this reason, the expert knowledge used is necessary to alter the existing time-series extrapolated model. Parameters describing future timber price trends, variations in future timber prices and the probabilities of future price peaks taking place are estimated by experts and recorded as additional information to the time model series.

1.1 Objectives of the thesis

It is well known that during the current crisis, the timber industry in Finland has been affected extensively, resulting in timber market recession and stagnation. The negative tendencies of the market have left the managers of timber industry wondering about the perspectives and the future of this trade in Finland. The prices for all timber assortments have dropped by a staggering 35% since 2007 to 2009. (Metla 2009.) This price behavior is the reason for the uncertainty in the future and is why managers of the sponsor company wish to gain knowledge in the field of forecasting.

The outcome will be a long-term forecast for timber prices in Finland for the period of 2008 until 2020, which will be used to develop the company's strategy for the future. The research topic was initiated by **Oy Karelkon Ltd**, a private company established in 1991 in Helsinki, Finland with a turnover of 5 954 000€ for 2008 (Kauppalehti 2009). Oy Karelkon Ltd specializes in timber products as their main activity and supplies the Finnish market with six main timber assortments that separate into 2 main product categories: (a) Roundwood, and (b) Pulpwood. These two main timber categories are both comprised of same three timber species: (a) Pine, (b) Spruce, and (c) Birch.

This study focuses on one timber assortment and its past and future prices due to vast research requirements that are limited by time. The product that is studied is the main trading product of the sponsor company the pine roundwood, the prices of which pose most interest to the managers.

The results of this study would be useful to the company because they will assist the managers in planning and strategy building. The study will also give the managers an understanding of the pine timber markets current position in the time-series compared to previously recorded statistics. The time-series is expected to indicate the current trend or cycle by evaluating previous analogies of the price variations. This in turn should aid in answering the question of in which direction the prices are heading.

1.2 Research questions

This thesis is based on two main research questions that are answered throughout the study of the topic. The first question deals with the theoretical framework behind forecasting while the second question implies a real-time implementation of the forecasting topic to a specific product. The two questions complement each other in such a way that both are studied through applying one on the other. The forecasting process of question one is studied through the application of the pine roundwood prices of question two.

1) What forecasting model is most appropriate to predicting future prices based on past values?

   - What main categories of forecasts exist?
   - How can the past data collection influence a forecast?
   - How to choose the correct forecasting model?
   - How to use a forecasting model?
   - What is the current positioning point of the prices in the model right now?
   - What were the main influences of price peaks in the past?
   - Can there be any analogies form the past data that can be modeled to the future?

2) What is the forecast for pine roundwood commodity prices until 2020?

- Are there any current trends?
- What variables can influence price variations?
- What are the future scenarios?
- How can expert knowledge and expert opinion influence the success of a forecast?

2 Research methodology

Forecasting and development of future price models is traditionally a quantitatively researched study based on evaluation, analysis of numerical data and its future decomposition into solid numerical predictions. This is true to almost all short-term forecasts, or forecasts requiring these quantitative techniques. However, long-term forecasts that are usually done for *tactical purposes* and typically applied to horizons of five to ten years or *strategic forecasts* with horizons of ten to fifty years are normally based on qualitative information obtained from experts in the field of interest. (Makridakis et al. 1998, 11.)

According to Aaker and Day (1999, 15), the sort of research that is undergone in this study, falls under the category of a **case study**, a comprehensive description and analysis of a single situation. An aim of a research using case studies is to seek conformity between theory and the results of findings. This research answers to all the requirements of a case study that is defined by Yin (2003, 13) as an empirical inquiry that investigates a contemporary phenomenon (in this case the specific forecasting concept) within its real-life context (application to a real-life product, for real-life use), especially when the boundaries between the phenomenon and the context are not clearly evident.

2.1 Research Methods

This particular case study applies qualitative research method combined with quantitative results represented by the time-series model. To enhance the outcome of the study and broaden the understanding in the topic, a chapter dedicated to the theory behind quantitative forecasting method is present, which deals with extrapolating the time-series model based on past data collection. This will benefit the study by showing what the forecast would be like, based on the previous data only, as well as serve as starting visual information that will be corrected by the qualitative tools. Finally, the triangulation method will be applied to bind the two parts and broaden the study enhancing the final results. The final results of the study will however be based on the outcome of collected qualitative information that will be applied to the quantitative estimates.

2.1.1 Quantitative research technique

This study will begin with a chapter dedicated to the quantitative aspects of forecasting, and will apply the theories behind forecasting directly to product of study, the pine roundwood assortment. **Quantitative** research is in itself a systematic investigation of quantitative properties and phenomena and their relationships. The objective of quantitative research in this study is to develop and employ mathematical model, theories and/or hypothesis that might best connect the phenomena to the research question. Quantitative method is a technique that is used to gather and analyze quantifiable data or information dealing with numbers and anything that is measurable. Statistics, tables and graphs serve as a wide spectrum of representation of results. This study will implement a widely used statistical branch in its beginning chapter. Statistical part will start with the collection of data, based on the hypothesis or the theory. A sample of data will be collected, that will from then on be used throughout the quantitative method's application. The results of this studies quantitative forecasting method will be recorded as a continuation of the collected data sample as well as represented visually by a chart. (see Myers 2009, 8.)

2.1.2 Qualitative research technique

In comparison to the quantitative method that operates with statistical models and interprets the findings numerically, the **qualitative** method focuses on studying the social and cultural phenomena in depth and interprets the findings with text (Myers 2009, 260). The key philosophical assumption upon which all types of qualitative research are based is the view that reality is constructed by individuals interacting with their social words. Qualitative researchers are interested in understanding the meaning people have and interpreting their meaning to practice in real world. (Merriam 1998, 6.) The qualitative research of this study belongs to the case study type; an intensive, holistic description and analysis of a single unit or a bounded system (Merriam 1998, 12).

All in all, the orientation of this study's qualitative research belongs to the **positivist** form of research, where education or schooling is considered to be the object of study (Merriam 1998, 4). Positivist studies generally attempt to test theory, in an attempt to increase the predictive understanding of phenomena, such as the case study at hand (Myers 2009, 37). The qualitative section of this study will be based on data collected through way of interviewing the experts in the field of interest. The expert opinions will then be analyzed and in conjunction with the AR1 forecasts complete the overall long-term forecast for the pine roundwood assortment

2.1.3 Research approach

Just as it is important to identify between the part of qualitative and quantitative methods, so is the selection of a relationship between empirical and theoretical research in the conducted study. Generally, the research may be theory driven (deductive), empirically driven (inductive), or the theory is leading the thought and acting as an accompanying discussion part (abductive). **Deductive** research means that theory is derived from a hypothesis and the validity is tested through the empirical research. On the other hand, **inductive** research means studying several individual cases and generalizing them into a theory. In **abductive** research the theory provides a clue or a hint, which the researcher attempts to prove through empirical research. Finally, the fourth research approach is the **constructive** research, which aims to solve a relevant practical problem by creating a new construction, which is formed through intensive dialogue between theory and the empirical research. (see Myers 2009, 8.)

The quantitative section of this study will naturally implement the deductive approach in connecting the theory to the empirical process. This relationship will be solely based on the forecasting models and their theories, and the empirical results will be constructed upon them.

The qualitative section will implement an inductive approach to the research. The relationship here will be based on studying several individual data sources and then generalizing and comparing them to the quantitative results.

This combination of the two methods is most rewarding for successful forecasts, as it is rather difficult to measure the usefulness of just the qualitative or quantitative information concerning price forecasting on its own. Qualitative data is most useful in providing hints and supplementing and aiding the quantitative forecast rather than providing a specific numerical forecast of its own. Combining data obtained from different sources and binding it, is known as triangulation. **Triangulation** is a method of implementing more than on research method or a technique, or a combination of any sort in one study. Triangulation is an excellent technique that allows to gain a fuller picture and to look at a problem from several angles. (Myers 2009, 10.) It is common to apply triangulation within case studies by combining qualitative and quantitative research methods, similar to the study at hand.

3 Applying forecasting theories to model future development

This chapter of the conducted study is dedicated to studying quantitative theories and properties of the forecasting subject. The focus here is on creating a relationship between the forecasting theory and its real life application to the product at hand. Pine roundwood assortment and its price serve as the product of study. The gathered data is of pine roundwood's past price records, and all the theories that are discussed focus on forecasting its future price development.

3.1 Sample identification

For this specific study, numerical data sample was gathered, that was used as the basis for forecasting and modeling future prices. Based on the statistical data of Metla organization, the official timber association statistical organization of Finland and with a combination of data extracted from Silva Fennica publications of Leskinen and Kangas 2001, it was possible to construct a time-series model for logging-year average pine roundwood prices of this study's interest for years 1950 until 2009. The prices for timber in Finland have first been observed, recorded and stored in 1950; therefore the time-series model shows the development of prices throughout a period of 59 years.

Table 1: Pine roundwood annual prices 1950-2008 (Metla 2008; Leskinen & Kangas 2001)

Year	Price	Year	Price	Year	Price
1950	25,71	**1970**	39,50	**1990**	48,74
1951	37,82	**1971**	42,02	**1991**	47,06
1952	67,23	**1972**	39,50	**1992**	36,98
1953	44,37	**1973**	40,34	**1993**	33,61
1954	44,71	**1974**	82,35	**1994**	36,98
1955	50,42	**1975**	73,95	**1995**	44,49
1956	43,53	**1976**	50,42	**1996**	43,54
1957	36,97	**1977**	53,78	**1997**	45,55
1958	36,97	**1978**	43,70	**1998**	46,97
1959	32,44	**1979**	48,74	**1999**	46,84
1960	38,66	**1980**	49,58	**2000**	48,32
1961	42,86	**1981**	53,78	**2001**	48,25
1962	42,18	**1982**	52,94	**2002**	47,73
1963	42,69	**1983**	47,90	**2003**	47,75
1964	47,06	**1984**	48,74	**2004**	47,18
1965	52,1	**1985**	50,42	**2005**	46,69
1966	47,90	**1986**	48,74	**2006**	48,29
1967	40,34	**1987**	43,70	**2007**	62,65
1968	31,93	**1988**	47,06	**2008**	61,11
1969	35,29	**1989**	49,58		

The data presented in table 1 has been gathered from two different sources and differs in the way that until 1995 the prices were recorded in Finish Marks as post 1995 prices were recorded in Euros. After applying the standard exchange rate of 5.95 FIM to 1 EUR, it was possible to achieve approximately exact figures for the early years of the figure and in combination with the most recent observations create a constant flow line under one statistical value of EUR.

3.2 Explanatory versus time-series forecasting

There exist two major types of forecasting models: (a) **self-projecting time-series** and (b) **explanatory models**. The quantitative forecasts that will be made to serve as the backbone of this study are of the self-projecting time-series.

An explanatory model or as also called a cause-and-effect approach, unlike the basic time series projection, assumes that the variable to be forecasted exhibits an explanatory relationship with one or more independent variables that affect the outcome of the forecast. For example, the gross national product or GNP is affected by a combination of factors such as inflation, capital spending, imports, exports, and errors. By evaluating the weight of each factor involved it is possible to calculate the GNP's final value by applying the observed current information. According to explanatory forecasting, any change in inputs will affect the output in a predictable way. (Makridakis et al. 1998, 10.) The explanatory model would however be too difficult to apply to this study, due to the large number of variables that affect the timber prices, as well as the high level of difficulty in recording these variables numerically.

Self-projecting time series forecasting is based on analyzing and extrapolating raw numerical past data of a variable into the future without considering any explanatory variables that cause the variation or change. The objective of this model is to simply identify the historical data series and extrapolate the existing pattern of it into the future without trying to discover factors affecting its behavior. There may be several reasons for preferring this model over others, one of which is: the system of the pattern development may not be understood, and even if it is understood it is extremely difficult to measure the relationships of the affecting factors that are assumed to govern the patterns behavior. Another reason for choosing this particular model may be that the main concern of a study is only to predict the future values according to the existing pattern of numerical data without trying to understand what are the reasons and factors that influence the curves development. (Makridakis et al. 1998, 10.) The self-projecting model fits this research best; therefore all onward quantitative forecasting models will be of this group.

If it is supposed that the future price variations in the timber market will be similar to those of the price development of the past, the time series model can be used as the basis of past time series data. This condition is known as the assumption of continuity, it is the underlying premise of all quantitative and many qualitative forecasting methods no matter how sophisticated they may be (Makridakis et al. 1998, 9). Unfortunately, there is no guarantee that the future extrapolation will behave according to past data. This may be due to too short period of data or to unpredicted future events that can have sufficient enough effect to change the timber price formation.

3.3 Box-Jenkins forecasting models

There exist a large number of different self-projecting time-series methods that are based on the type of numerical data at hand. These include such popular forecasting methods as *exponential smoothing, decomposition and regression* models that all have their own specific use in the area of forecasting. The method that is most appropriate for long-term price forecasting based on previous time-series and one that will be applied in this study is the **Box-Jenkins** forecasting method. This is a method that was introduced and popularized by George Box and Gwilym Jenkins in the early 1970s, and their names have been synonymously used with this general method (Makridakis et al. 1998, 312). A number of previous similar studies such as Leskinen and Kangas (2001) research of future timber price development in Finland, suggest that this forecasting method for price forecasting of timber assortments in Finland. The study done by Leskinen and Kangas is of the outmost similarity, but as it was created almost 9 years ago the results of the past research are now outdated, and can be renewed to project into the further future.

The Box-Jenkins forecasting method is a self-projecting time-series forecasting method the underlying goal of which is to find an appropriate formula so that the errors or otherwise called residuals are as small as possible and exhibit no pattern. The model building and selection process involves several steps, repeated as necessary, to end up with a specific formula that replicates the patterns in the time-series as closely as possible and also produces accurate forecasts. (Arsham 2009, 49-50.) The Box-Jenkins method offers several classes of models for forecasting and a systematic approach for identifying the correct model form to be applied according to their relevance with the time-series data. These models are based on statistical concepts and principles and are able to model a wide spectrum of time-series behavior. (Arsham 2009, 50.) Unlike many traditionally used forecasting methods that are normally ineffective with forecasting the long-term and offer few models choices, the Box-Jenkins method is the most suitable.

3.4 ARIMA, auto-regression model

The forecasting models that were popularized by Box-Jenkins are known as the **ARIMA** methodology. ARIMA models are divided into three main categories of forecasting: (a) **AR** or an autoregressive model, (b) **MA** or the moving average model, (c) **ARMA** a combination of the two models. When regular differencing is applied, together with AR and MA, they are referred to as ARIMA, with the "I" indicating, "integrated" and referencing the differencing procedure. (Arsham 2009, 50.) A model that depends only on the previous outputs of the system is called an autoregressive model or is abbreviated as AR, while a model that depends only on the inputs to the system is called a moving average model and is similarly abbreviated as MA, and of course a model based on both inputs and outputs is an autoregressive-moving-average model or ARMA. (Makridakis et al. 1998, 312.)

Autoregressive processes as the name implies, is a form of regression where instead of the variable to be forecast being related to other explanatory variables, it is related to past values of itself at varying but equal time lags (Berenson, Levine & Krehbiel 2009, 781). The autoregressive model follows a general formula represented below:

***Pth*-Order Autoregressive Models**

$Y_{(t)} = A_0 + A_1 Y_{(t-1)} + A_2 Y_{(t-2)} + A_2 Y_{(t-3)} + \dots + A_p Y_{(t-p)} + \varepsilon_t$

Where:

$Y_{(t)}$= the observed value at time *t*

$Y_{(t-1)}$= the observed value at time *t*-1

$Y_{(t-2)}$ = the observed value at time *t*-2

$Y_{(t-p)}$= the observed value at time *t-p*

$A_{0,}$ $A_{1,}$ $A_{2,\dots,}$ A_p = autoregressive parameters to be estimated from least-squares regression analysis

ε_t = a non-auto correlated random error component (with mean = 0 and a constant variance)

(Berenson et al. 2006, 781).

The general formula is applied to specific time-series in the later stages, and through a process of evaluation and analysis adapts a certain *p*-order that fits the series at hand. The first-order autoregressive model is similar in form to the simple regression model, and satisfies the following formula (Berenson et al. 2006, 781):

First-Order Autoregressive Model

$$Y_{(t)} = A_0 + A_1 Y_{(t-1)} + \varepsilon_t$$

The second-order autoregressive model is similar to the multiple regression models with two independent variables and satisfies the following formula (Berenson et al. 2006, 781):

Second-Order Autoregressive Model

$$Y_{(t)} = A_0 + A_1 Y_{(t-1)} + A_2 Y_{(t-2)} + \varepsilon_t$$

The rule behind the order of the model is such that, the order dictates the number of variables to be included in the formula.

The ARIMA method consists of a vast number of various models that is each adapted to a specific time-series. In order to select an appropriate model for successful application, a series of preparation and examination tests have to be implemented. The Box-Jenkins approach to modeling time-series consists of three phases: (a) Identification, (b) Estimation and testing, (c) Application. The visual schematics for the approach can be observed in figure 1.

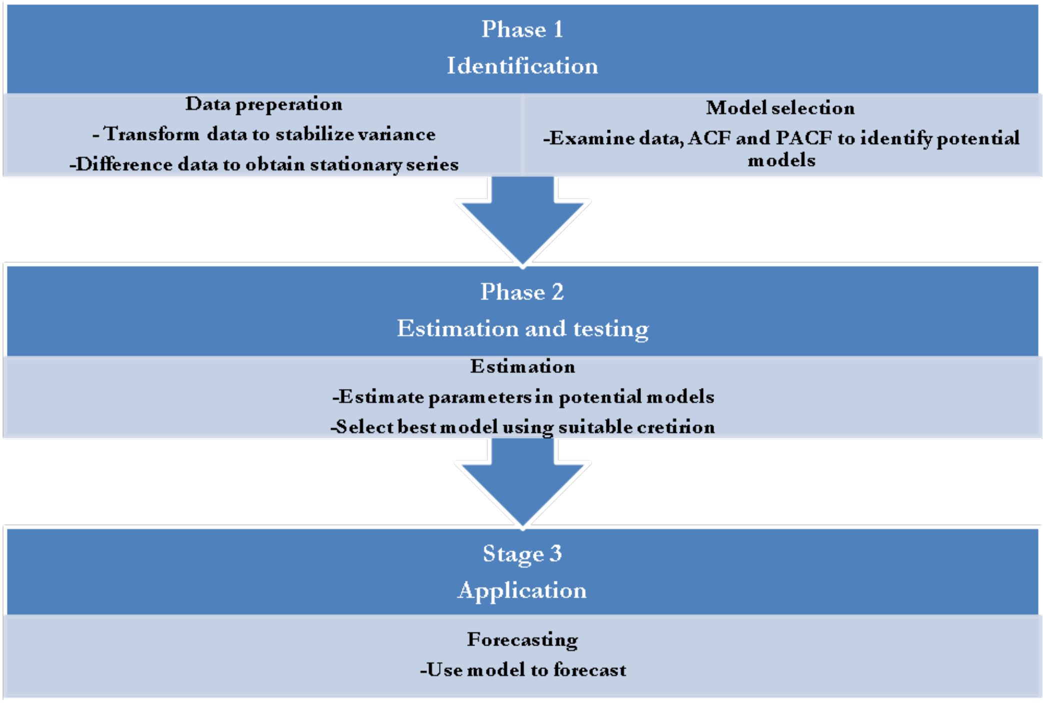

Figure 1: Box-Jenkins modeling approach divided into phase implementation (by the author)

3.5 Data Preparation

Pine roundwood prices given in the table 1 will be applied throughout all examples of theoretical explanations and implementations of the ARIMA process. The past price series of pine roundwood is visually represented by the figure 2.

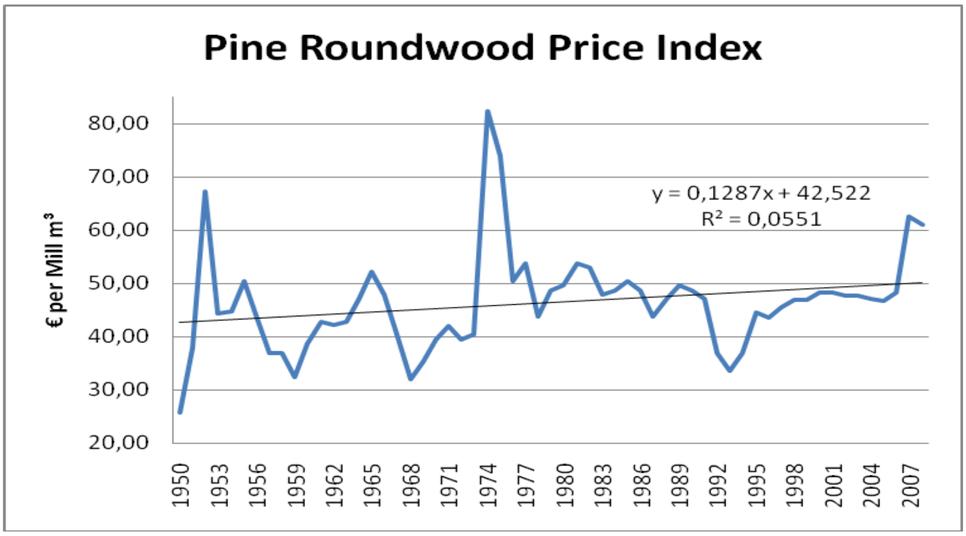

Figure 2: Price time-series index for pine roundwood, with trend line and R^2 (Metla, 2008; Leskinen & Kangas 2001)

By visually analyzing the past price series it is obvious to recognize the peaks that were observed in years 1952, 1974 and 1975. As well as the peaks, there are obvious drops of prices in years 1959, 1968 and 1993. These price peaks and price drops are outcomes of specific variable effects on the industry at large. These peaks have occurred due to certain influences that will be studied at the later point in the study. The occurrences of high peaks and low drops destabilize the rest of the data-series and considerably decrease the coefficient of prediction, or the R^2.

The coefficient of determination or R^2 is used in statistical modeling where the main purpose is the prediction of future outcomes on the basis of related information. R^2 is given by a proportion or a percentile and estimates the variability in a data set that is accounted for by the statistical model. It provides a measure of how well future outcomes are likely to be predicted by the model.

The peaks and drops are not abnormal occurrences in a series, and their initiating causes and outside effects can always be explained qualitatively. To generate a more reliable time-series without the considerable effect that the peaks and drops have on it, it is wise to eliminate them by way of replacement with surrounding averages. The averages will be calculated by adding to the peak prices the two surrounding prices and taking the average of the total. This resulting price will replace the peak price. This action will add some stability to the variance in the series, thus making it more reliable to forecasting. The causes of past price extremes as well as the possibility of their similarities in the future will be discussed in the later chapters.

After eliminating the most extreme price recordings, the time series stabilizes considerably. Figure 3 represents the pine roundwood price series without the price peak and the price drops where the coefficient of determination has risen as an outcome. The R^2 of the altered series is still quite low, implying that only a small portion of the price trend is explained by the linear series. Following the data preparation stage is the data analysis stage, where the collected data will be studied and the forecasting model selected accordingly.

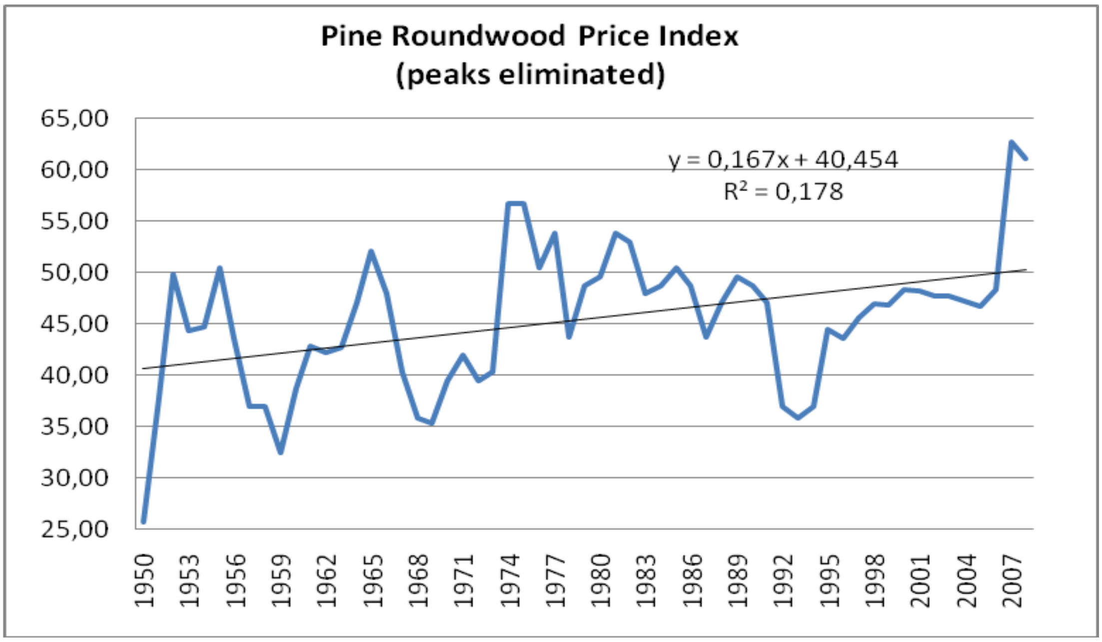

Figure 3: Time-series of pine roundwood prices after eliminated the effects of price peaks by way of taking the averages of the prices surrounding the price peak years of 1952, 1974 and 1975

3.6 Autocorrelation Coefficient Function (ACF)

The most crucial statistic component in time-series analysis is the **autocorrelation coefficient** also known as **ACF** or the correlation of the time-series with itself lagged by one, two or more periods. For example if we compare Y (t), an observation at time (t), with Y $(t\text{-}1)$, an observation made at time $(t\text{-}1)$, then we see how the two consecutive observations are related. Table 2 shows us the spruce round wood species data series over a period of 59 years, where observations $Y_{1,}$ $Y_{,2,}$ $Y_{3,\ldots}$ $Y_{59,}$ shown in column 2, are observed at time periods 1, 2, …59, shown in column 1. If we lag the series by one period, as shown in column 3, then there will be 58 observations to compare, for which the correlation can be calculated. However, since they are one and same series, the summary measures are called autocorrelation. Equation 1 illustrates the formula for autocorrelation where it is denoted by (r_k)

Equation 1: Autocorrelation (ACF) equation (Makridakis et al. 1998, 39)

$$r_K = \frac{\sum_{t=k+1}^{n} \left(Y_t - \overline{Y}\right)\left(Y_{t-k} - \overline{Y}\right)}{\sum_{t-1}^{n} \left(Y_t - \overline{Y}\right)^2}$$

Table 2: Example of autocorrelation calculation in Excel for pine roundwood price data where values 5 through 56 follow the same calculation pattern as those in the table

Period	$Y_{(t)}$	$Y_{(t-1)}$	$Y_{(t)}-\bar{Y}$	$Y_{(t)}-\bar{Y}$	$(Y_{(t)}-\bar{Y})^2$	$(Y_{(t)}-\bar{Y})/Y_{(t-1)}-\bar{Y})$
1	25,71		25,71		661,21	
2	37,82	25,71	37,82	25,71	1429,97	972,37
3	67,23	37,82	67,23	37,82	4519,34	2542,15
4	44,37	67,23	44,37	67,23	1968,61	2982,75
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
57	48,3	46,69	1,91	0,31	3,64	0,59
58	62,7	48,29	16,27	1,91	264,62	31,02
59	61,1	62,65	14,73	16,27	216,89	239,56
Sum	**2737**				**5144,47**	**2325,21**

Where

Mean:

$$\bar{Y} = \frac{2736,6}{59}$$

$$\bar{Y} = 46,38$$

Autocorrelation at lag one:

$$ACF1 = \frac{2325,21}{5144,47}$$

$$ACF1 = 0,45$$

Together, the autocorrelations at lags one, two, and so forth make up the autocorrelation function or the ACF. After applying the ACF to a time-series it is necessary to create visual plots of autocorrelation against lag. Such plots are known as **correlograms** and are a used as a standard tool in exploring time-series before forecasting. Correlograms provide insight to whether there is any seasonality, cycles, or other patterns involved in the specific time-series. The ACF also helps to identify if the previous values of the series contain much information about the next value, or whether there is little relationship between one observation and the next. (Makridakis et al. 1998, 38.)

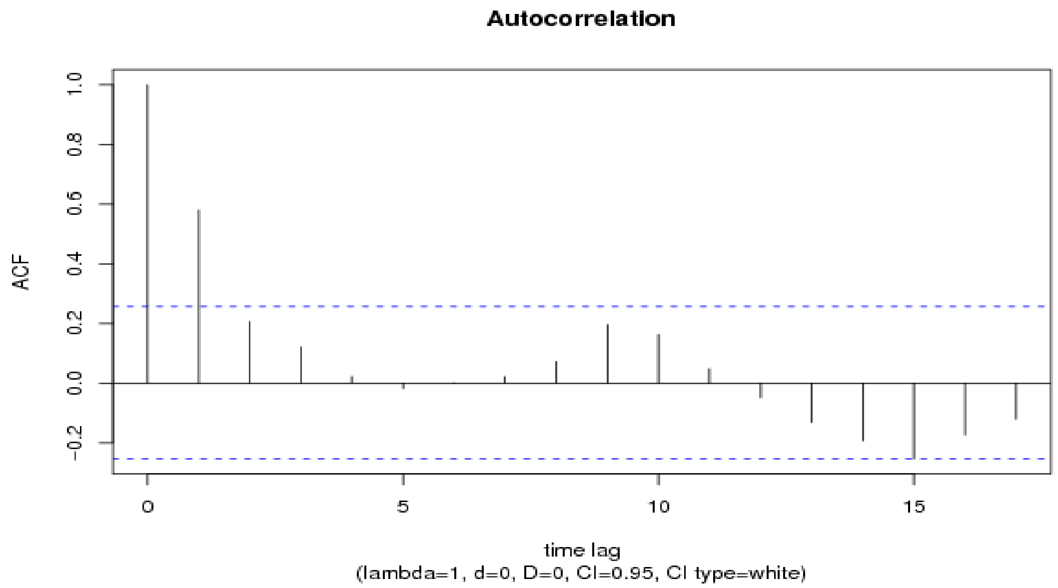

Figure 5 is ACF plot or a correlogram of the pine roundwood price data, where upper and lower error limit range can be observed with a dotted line

Represented by the upper and lower limits are the critical values, identification of which is done by implementing a standard formula. This standard formula derived from statistical mathematics, and implies that 95% of all sample autocorrelation coefficients must lie within a range that is specified by the mean plus or minus 1.96 standard errors, where a standard error is $1/\sqrt{n}$. The final formula for calculating the upper and lower limits is $\pm 1.96/\sqrt{n}$ where (n) is the number of observations. (Makridakis et al. 1998, 317.) The correlogram representing the pine roundwood price autocorrelation coefficients applies the following formula for determining the upper and lower critical values, $\pm 1.96/\sqrt{58}$, the outcome is represented by a critical range at $\pm$ 0,26. Critical value range is a benchmark that determines if an autocorrelation is significantly large or not. Autocorrelations that fall within the boundaries can be safely ignored, while those that fall outside the boundaries suggest there may be some additional information about the series. Usually a high coefficient at lag 12 would indicate a seasonal pattern, meaning that the data 12 months apart has similarities and therefore has the tendency to repeat itself. When there is no pattern in the ACF series, it is said to represent a white noise. (Makridakis et al. 1998, 52.) Since the round wood spruce data is measured over a period measured in years, we can safely ignore seasonality and its effects due to seasonality not affecting yearly data of most series, while normally it would be included in the final formula.

The correlogram of the pine roundwood price data in figure 5 reveals a high correlation between observations at one lag apart indicated with a large spike that exceeds the critical boundaries. This denotes that every subsequent observation is substantially influenced by the previous one. The ACF plot revealed high correlation between subsequent values in the series but no other valuable information concerning the series could be extracted. ACF analyses concludes by advising the implementation of one lag apart correlation of values, or simply order one model.

3.7 The Partial Autocorrelation Coefficient (PACF)

The second most valuable instrument used in ARIMA model identification process is the **partial autocorrelation coefficient** or the **PACF**. Specifically, partial autocorrelations and the PACF plots are useful in identifying the order of an autoregressive model. If the sample autocorrelation plot or the ACF indicates that an AR model may be appropriate, then the sample partial autocorrelation plot is examined to help identify the order. (Box & Jenkins 1970, 64-65.)

Partial autocorrelations are used to measure the degree of association between $Y_{(t)}$ and $Y_{(t-k)}$, when the effects of other time lags are removed. (Makridakis et al. 1998, 320.) For example, the partial autocorrelation coefficient for order k=5 is computed in such a manner that the effects of the k=1, 2, 3, and 4 partial autocorrelations have been excluded (Arsham 2009, 57). As with the ACF, the partial autocorrelation should be close to zero for a white noise series, then the estimated partial autocorrelations are approximately independent and normally distributed with a standard error $1/\sqrt{n}$. Therefore the same critical value formula $\pm 1.96/\sqrt{n}$ is applied to assess if the data are white noise.

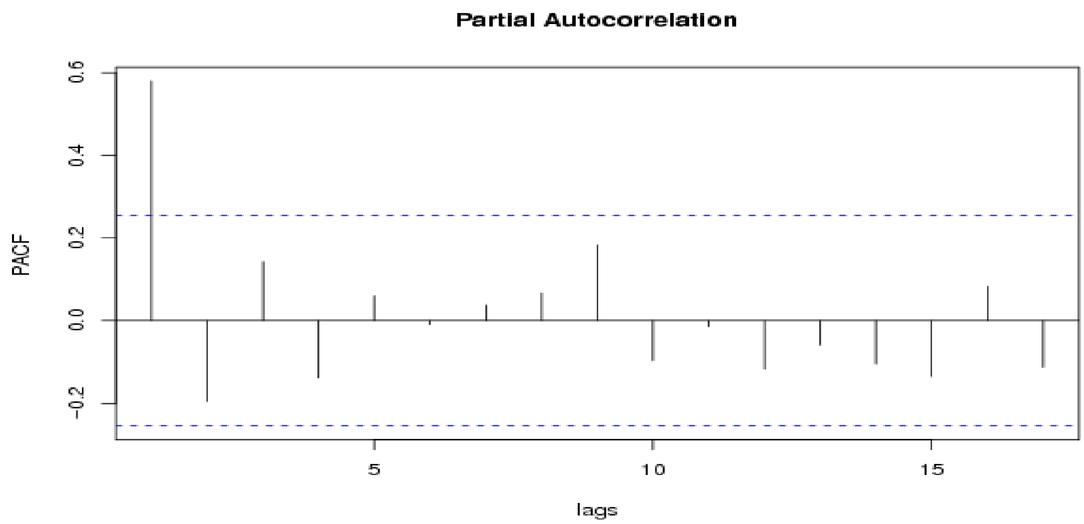

Figure 6: PACF plot for pine roundwood prices where upper and lower error limit range can be observed with a dotted line

The PACF plot of pine roundwood data reveals a strong relationship of partial autocorrelations with one lag apart, indicated by a large spike at lag one. Similarly to the ACF, the PACF did not uncover any hidden patterns other than those at lag one.

3.8 Examining Stationary of the Time-Series Data

A crucial factor for implementing the ARIMA models successfully is the stationary of the data aspect. In order for the forecasts to be as precise as possible, they must rely on the data that is roughly stationary in its mean and variance. When judging a time-series plot, the data must be roughly horizontal along the time axis and fluctuate around a constant mean, independent of time, and the variance of the fluctuation remains essentially constant over time (Markidakis et al. 1998, 324). The visual plot of a time series often provides enough evidence to understand whether the data is stationary or non-stationary. A stationary time-series would be represented by a quite horizontally distributed data over time, when the non-stationary series would look like an exponential rise or decline.

Detecting stationary may not always be as easy as glancing at the time-series plot. For concrete evidence of stationary, the ACF and the PACF plots must be analyzed. The ACF plot can usually expose the non-stationary in the mean. The autocorrelations of stationary data drop to zero relatively quickly, while the non-stationary series they are significantly different from zero for several time lags (Makridakis et al. 1998, 324). When represented graphically, the autocorrelations of non-stationary data decrease slowly as the number of time lags increases. A PACF plot would normally expose non-stationary with a large spike close to 1 at lag 1. For evidence of stationary, both ACF and the PACF plots must show the residuals lying within the critical values, or at least 95% of the values to be within the boundaries.

As the ACF and PACF of the pine roundwood price series suggest, the data at hand is not stationary. This is revealed by spikes at lag 1 exceeding the 95% critical boundaries in both ACF and PACF, a common sign of non-stationary. In order to successfully proceed with the forecast, the data needs transformation to achieve stationary status.

3.9 Differencing

Trends and other non-stationary patterns in the time-series result in positive autocorrelations that dominate the autocorrelation diagram. Therefore it is important to remove the non-stationary condition so other correlation structure can be identified and used for the time-series model building. The most common method of removing the non-stationary condition is the differencing. Differencing can be defined as the change between each observation and its predecessor, and follows the formula: $Y'_{(t)} = Y_{(t)} - Y_{(t-1)}$. (Makridakis et al. 1998, 326.)

Table 3 illustrates the first differences process implemented to the pine roundwood prices. The differenced series will consist of only n-1 values or one value less than the original number of observations, since it is not possible to calculate the difference of Y'1 for the first observation (see Makridakis et al. 1998, 327).

Taking first differences is a very useful tool for removing non-stationary, however occasionally the differenced data will not appear stationary and it may be necessary to difference the data a second time. The second differencing is done in exactly similar way as the first, by calculating the change between the progressing observations. The second differencing is represented with a formula $Y''_{(t)} = Y'_{(t)} - Y'_{(t-1)}$, where $Y''_{(t)}$ is referred to as the series of second-order differences. It is very rare to go beyond the second-order differences, because it is almost always sufficiently enough transformation to eliminate the non-stationary. (Makridakis et al. 1998, 328.)

Table 3: Example of first differences calculation in MS Excel for pine roundwood price data. Values for the years of 1954 until 2005 follow the same calculation pattern as those in the table

Year	Y value	Differencing Calculation	Differencing Result
1950	25,71		
1951	37,82	37,82-25,71=	**12,10**
1952	49,80	49,80-37,82=	**11,99**
1953	44,37	44,37-49,80=	**-5,43**
.	.	.	.
.	.	.	.
.	.	.	.
2006	48,29	48,29-46,69=	**1,6**
2007	62,65	62,65-48,65=	**14,36**
2008	61,11	61,11-62,65=	**-1,54**

3.10 Differenced Data Analysis

In cases where initial data analysis indicates non-stationary in the series, and differencing is applied to achieve stationary, a second round of analysis has to be performed on the newly recorded values in order to validate the results of differencing process. Analysis of differenced values fully repeats the analysis of initial data. For prove of stationary in the new series, the ACF and PACF must be applied and examined accordingly.

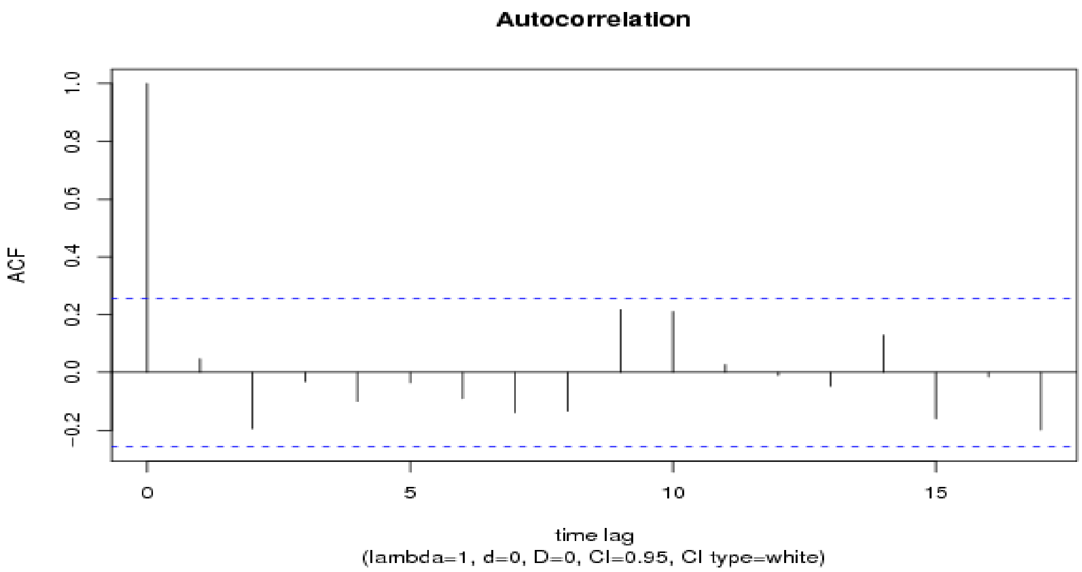

Figure 7: ACF plot for pine roundwood prices after first differences

Figure 7 is a correlogram based on the first differenced values of pine prices, where all the residuals clearly lay within the error limits. The differenced values in the ACF plot represent a white noise series now, and show all signs of stationary.

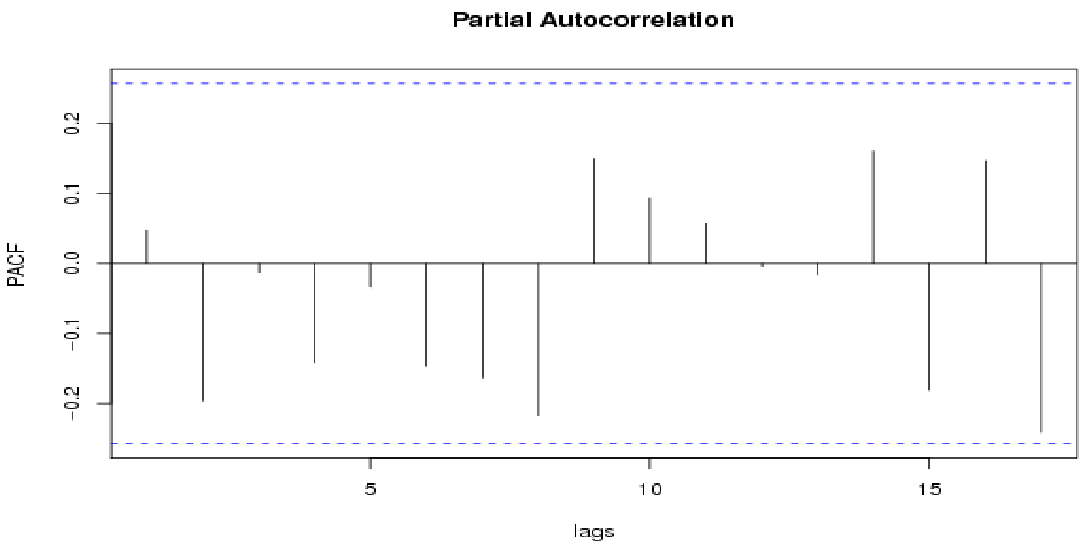

Figure 8: PACF plot for pine roundwood price species after first differences

For more prove of stationary, the PACF is applied and results analyzed. Figure 8 graphically illustrates the PACF results of first differenced values. Similarly to the ACF plot, the PACF values all lay within the error range thus represent a white noise series. The stationary condition has been successfully achieved through first differences, and it is now safe to continue with auto regression forecast implementation.

3.11 Model Selection

Appropriate autoregressive model selection can be complicated. The main rule that must be followed is, one must weigh the advantages that are due to simplicity against the concern of failing to take into concern important autocorrelation in the data. (Berenson et al. 2006, 781.) This rule implies that, it is preferable to minimize the order of the model to as low as possible, while not neglecting to include all the necessary data in the model. All autocorrelations and partial autocorrelations that are significantly different from zero and exceed the critical limits would have an impact on the model selection, where they would be taken into account as necessary relationships to the future forecasts.

The data analysis stages have revealed no extraordinary connections between values that are equal lags apart, thus no repeating patterns need to be implemented. Seasonality was eliminated due to data representing annual yearly prices that do not have any seasonal effects on each other. A low coefficient of determination in the series due to price values varying indicates quite low chance of predicting an exact value for the future years. Even though the forecasts that will be applied are correct in their methods, the results achieved will not be spot on exact, but rather give an idea of the direction for the future. Since it is quite clear from the analysis of the data that the results will be of approximate certainty, it provides much freedom for the choice of the model. More sophisticated models of higher orders, are aimed at minimalizing the errors and giving an as close as possible prediction of the future values. For this particular time-series of pine roundwood price data, the most appropriate forecasting model based on the initial analysis is the AR1 model or the autoregressive model of order one.

A similar research undergone by Leskinen and Kangas in 2001, where the aim was to forecast the future timber price development in Finland, used exactly the same ARIMA process. The historical data in question was the same as in this study, therefore allowing on relying on the same model selection as Leskinen and Kangas. The forecast model that was chosen by Kangas and Leskinen was the autoregressive model of order one or AR1. Supported by the previously tested research, the final selection of the forecast model falls on the AR1 model.

3.12 Estimating Parameters with Least Squares Estimate Method

In autoregressive models, the parameters of the key equation are given by symbols $A_0, A_1, A_2, \ldots, A_p$, with corresponding estimates denoted by $\alpha_0, \alpha_1, \ldots \alpha_p$. These key parameter values are computed by applying the so called least-squares method to the data series. (Berenson et al. 2006, 781.) The parameters of the simple AR1 model are calculated by adapting a simple linear regression equation, while the parameters for all the higher-order AR models are computed by implementing a multiple linear regression equations (Berenson et al. 2006, 607).

In previous chapters a standard autoregressive equation was presented as:

$$\hat{Y}_{(t)} = \alpha_0 + \alpha_1 Y_{(t-1)} \ldots + \alpha_p Y_{(t-p)} + \varepsilon_t$$

Where:
$\hat{Y}_{(t)}$ = predicted value of Y for observation *t*
α_0 = sample Y intercept
α_1 = sample slope

This autoregressive equation requires the determination of two regression coefficient: (a) α_0, and (b) α_1. The most common approach to finding α_0, α_1 is the method of least squares. This method minimizes the sum of the squared differences between the actual values $Y_{(t)}$ and the predicted value $\hat{Y}_{(t)}$ using the simple linear regression equation. (Berenson et al. 2006, 608.) The goal of the least squares estimation is to obtain a line of best fit, or as also know a trend line for the data series. The line of best fit is chosen to be one which yields the smallest value for the sum of the squared errors or SSE as represented by the formula in equation 2. (Makridakis et al. 1998, 190.)

Equation 2: Sum of squared error (SSE) equation (Berenson et al. 2006, 621)

$$\sum_{i=1}^{n}(Y_i - \hat{Y}_i)^2 = \sum_{i=1}^{n}\left[Y_i - \left(\alpha_0 + \alpha_1 * Y_i\right)\right]^2$$

The determination of the autoregressive parameters can be estimated through a series of mathematical calculations by applying statistical formulas to the values obtained by calculations given in table 4.

Table 4: Example of parameter calculations in Excel for pine roundwood data. Values for the years of 1954 until 2005 follow the same calculation pattern as those in the table

Year	Year Number (X)	Price Value (Y)	X²	Y²	XY
1951	1	12,10	1	146,41	12,1
1952	2	11,99	4	143,7601	23,98
1953	3	-5,43	9	29,4849	-16,29
1954	4	0,34	16	0,1156	1,36
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
2006	56	1,6	3136	2,56	89,6
2007	57	14,36	3249	206,2096	818,52
2008	58	-1,54	3364	2,3716	-89,32
Totals/Sum	**1711**	**35,40**	**66729**	**1617,15**	**923,02**

Equation 3: Computation formula for slope α_1 (Berenson et al. 2006, 612)

$$a_1 = \frac{SSXY}{SSX}$$

Equation 4: Computation of SSXY, sums of squares of X and Y multiplied (Berenson et al. 2006, 612)

$$SSXY = \sum_{i=1}^{n}\left(X_i - \overline{X}\right)\left(Y_i - \overline{Y}\right) = \sum_{i=1}^{n} X_i * Y_i - \frac{\left(\sum_{i=1}^{n} X_i\right)\left(\sum_{i=1}^{n} Y_i\right)}{n}$$

$$SSXY = 923{,}02 - \frac{(1711)(35{,}4)}{58}$$

$$SSXY = 923{,}02 - 1044{,}3$$

$$SSXY = -121{,}28$$

Equation 5: Computation of SSX, sum of squares of X (Berenson et al. 2006, 612)

$$SSX = \sum_{i=1}^{n}\left(X_i - \overline{X}\right)^2 = \sum_{i=1}^{n} X_i^2 - \frac{\left(\sum_{i=1}^{n} X_i\right)^2}{n}$$

$$SSX = 66729 - \frac{(1711)^2}{58}$$
$$SSX = 66729 - 50474{,}5$$
$$SSX = 16254{,}5$$

Therefore

$$\alpha_1 = \frac{-121{,}28}{16254{,}5}$$
$$\alpha_1 = -0{,}0075$$

Computation formulas for Y intercept α_0

$$\alpha_0 = \overline{Y} - \alpha_1 \overline{X}$$

Computation of Y mean

$$\overline{Y} = \frac{35{,}40}{58}$$
$$\overline{Y} = 0{,}61$$

Computation of X mean

$$\overline{X} = \frac{1711}{58}$$
$$\overline{X} = 29{,}5$$

Therefore

$$\alpha_0 = 0{,}61 - (-0{,}0075 * 29{,}5)$$
$$\alpha_0 = 0{,}83$$

Excel is a very helpful tool in determining parameters for time-series. After plotting the data graphically, it is possible to apply the trend line tool directly to the gathered data. Excel applies the least squares method for trend line calculations and shows the corresponding equation for it. In Figure 8 where the time series presents the pine roundwood prices after first differences, such trendline is presented with a straight line positioned in the middle range of all values. The equation of this trendline is also presented in Figure 8, where the parameter values are same as those calculated through the least squares estimation process.

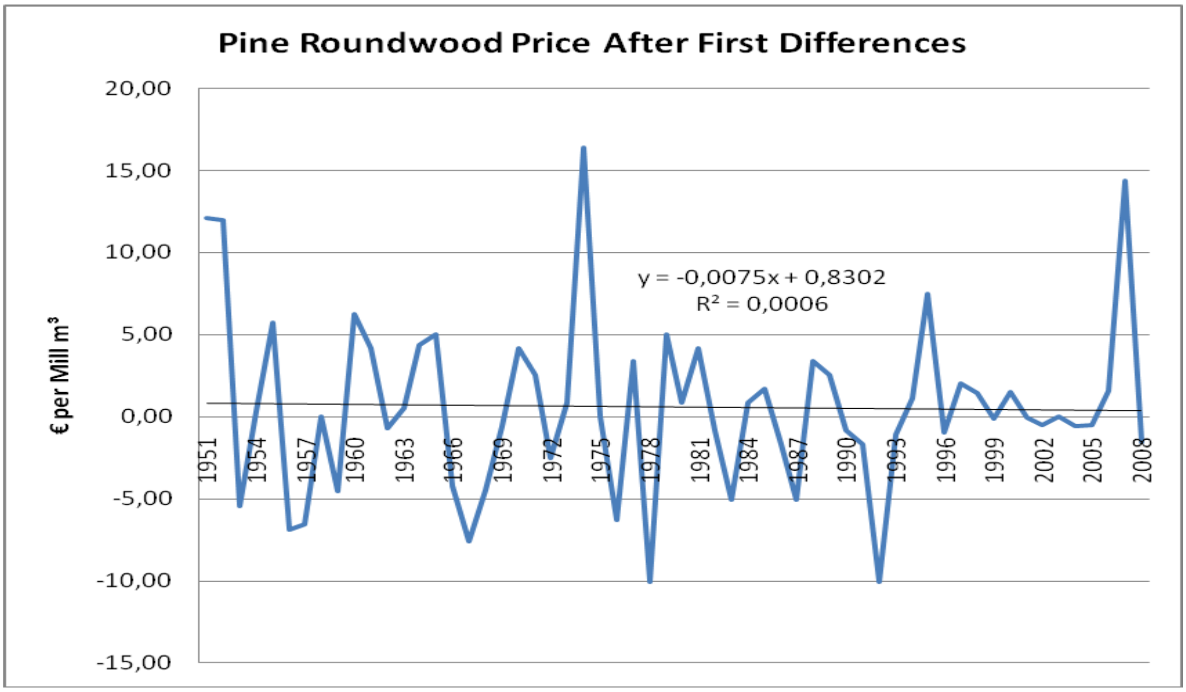

Figure 8: Time series of pine roundwood prices after first differences, with a trend line and an equation explaining this particular trend line

After successfully estimating all the necessary parameters required for the chosen forecasting model, it is possible to implement the model in practice. The next stage will be the actual forecasts based on the previous data.

3.13 Forecasting with AR1

After all preparation stages have been successfully surpassed, and parameters for the time series established, it is now possible to apply the forecasting AR1 model. The AR model of order one is applied to the differenced values, and the parameters that are used are of the differenced series. Table 5 shows the AR1 model to the differenced pine roundwood price series, where after acquiring the results in shape of differenced forecasts they are shifted back to the original series values. AR1 formula used to forecast the spruce series is of the following form:

First-Order Autoregressive Model

$Y_{(t)} = A_0 + A_1 Y_{(t-1)} + \varepsilon_t$

Table 5: Pine roundwood price series fitted with AR1 forecast model

2008: current year, Y_{59} = 61,11
First difference, $\hat{Y}_{58}$ = -1,54
2009: 1year ahead, $\hat{Y}_{59}$ = -0, 0075+0, 8302 * (-1, 54) = -1, 29
Removing differences: 61, 11+ (-1, 29) = 59, 82
2010: 2 year ahead, $\hat{Y}_{60}$ = -0, 0075+0, 8302 * (-1, 29) = -1, 08
Removing differences: 59, 82+ (-1, 08) = 58, 75
2011: 3year ahead, $\hat{Y}_{61}$ = -0, 0075+0, 8302 * (-1, 08) = -0, 90
Removing differences: 58, 75+ (-0, 90) = 57, 85
2012: 4 year ahead, $\hat{Y}_{62}$ = -0, 0075+0, 8302 * (-0, 90) = -0, 75
Removing differences: 57, 85 + (-0, 75) = 57, 09
2013: 5 year ahead, $\hat{Y}_{63}$ = -0, 0075+0, 8302 * (-0, 75) = -0, 63
Removing differences: 57, 09+ (-0, 63) = 56, 46
2014: 6year ahead, $\hat{Y}_{64}$ = -0, 0075+0, 8302 * (-0, 63) = -0, 53
Removing differences: 56, 46+ (-0, 53) = 55, 93
2015: 7 year ahead, $\hat{Y}_{65}$ = -0, 0075+0, 8302 * (-0, 53) = -0, 45
Removing differences: 55, 93+ (-0, 45) = 55, 48
2016: 8 year ahead, $\hat{Y}_{66}$ = -0, 0075+0, 8302 * (-0, 45) = -0, 38
Removing differences: 55, 48+ (-0, 38) = 55, 09
2017: 9 year ahead, $\hat{Y}_{67}$ = -0, 0075+0, 8302 * (-0, 38) = -0, 32
Removing differences: 55, 09+ (-0, 32) = 54, 77
2018: 10 year ahead, $\hat{Y}_{68}$ = -0, 0075+0, 8302 * (-0, 32) = -0, 28
Removing differences: 54, 77+ (-0, 28) = 54, 49
2019: 11 year ahead, $\hat{Y}_{69}$ = -0, 0075+0, 8302 * (-0, 28) = -0, 24
Removing differences: 54, 49+ (-0, 24) = 54, 25
2020: 12 year ahead, $\hat{Y}_{70}$ = -0, 0075+0, 8302 * (-0, 24) = -0, 20
Removing differences: 54, 25+ (-0, 20) = 54, 05

The numerical results are recorded, and added to the time series as a continuation to the previous values. Time-series of spruce timber prices given in figure 9 includes the plotted AR1 forecasts that visually interpret the findings.

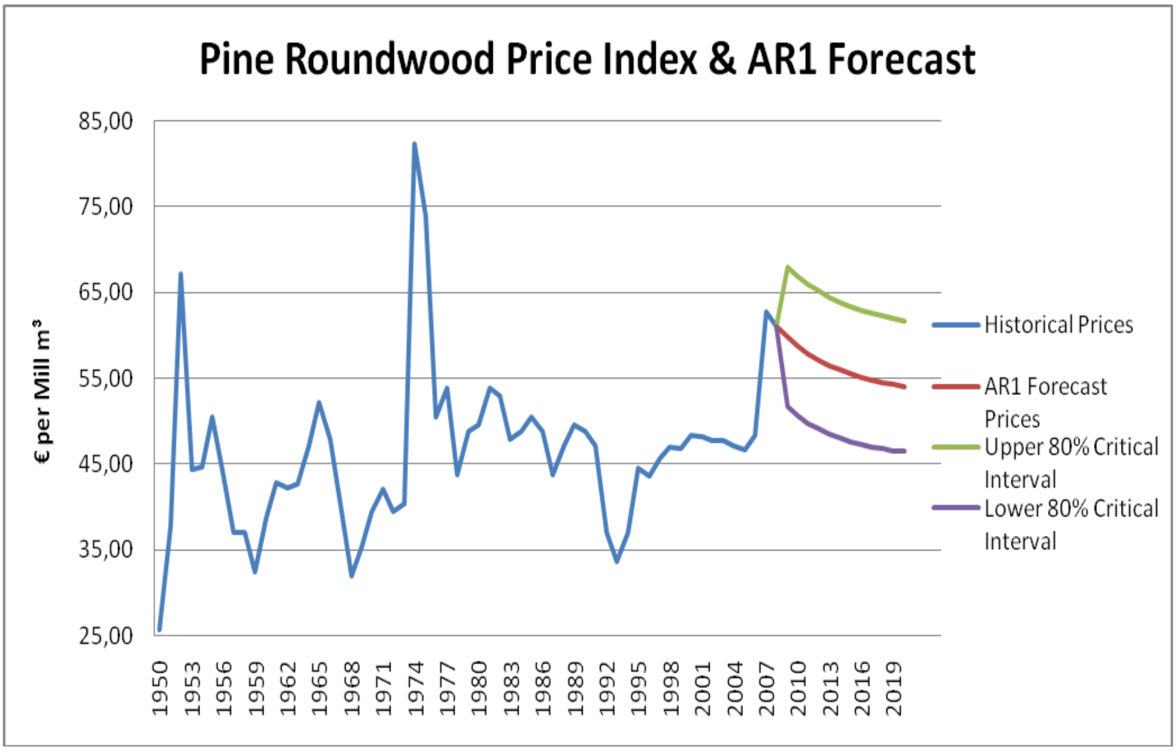

Figure 9: Pine roundwood prices time-series including AR1 forecasts, as well as lower and upper 80% prediction intervals

3.14 Prediction Intervals

A valuable addition to the forecasting models is the implementation of the prediction intervals. A prediction interval is an estimate of an interval in which the forecasted future values will fall, with a certain probability, given what has already been observed. Prediction intervals are used to predict the response for an individual value in addition to calculating the predicting value $\hat{Y}$, by constructing a prediction interval. (Berenson et al. 2006, 643.) An example of such interval applied to the pine roundwood price series is exhibited in figure 9, where the AR1 forecasts are accompanied with 80% upper and lower prediction intervals. The interval given in figure 9 represents the boundaries within which with 80% confidence lye the variation of predicted prices. It is often very desirable to provide not only the forecast values but the accompanying uncertainty statements as well. This is useful because it provides the user with the best and worst case estimates that could be anticipated. (Makridakis et al. 1998, 52.)

The prediction interval for an individual response, Y, at a particular value, X_i, denoted by $Y_{x=Xi}$, is defined by the following equation:

Equation 6: Prediction interval for an individual response, Y (Makridakis et al. 1998, 53)

$$\hat{Y}_i \pm Z\sqrt{MSE}$$

$$\hat{Y}_i - Z\sqrt{MSE} \leq Y_x = X_i \geq \hat{Y}_i + Z\sqrt{MSE}$$

The value of Z determines the width and probability of the prediction interval. The value of Z is chosen from preset values that determine appropriate probability to be used. Such preset values of Z can be observed in table 6, where the most commonly used probability percentages are accompanied by their appropriate Z values. For example, Z = 1, 96 gives a 95% prediction interval. This means that, the interval has a probability of 95% of containing the true value. (Makridakis et al. 1998, 53.) The prediction intervals in the spruce price series AR1 forecast in figure 9, implemented an 80% confidence probability, therefore the Z value used was 1,282.

Table 6: The Z values and their corresponding probability percentages (Makridakis et al. 1998, 53)

Z	Probability %
0,674	50
1	68
1,15	75
1,282	80
1,645	90
1,96	95
2,576	99

The rest of the unknown variables can be calculated through the implementation of the following equations:

Equation 7: Mean squared error, MSE (Berenson et al. 2006, 621)

$$MSE = \frac{SSE}{n-1}$$

Equation 8: Error sum of squares, SSE (Berenson et al. 2006, 621)

$$SSE = \sum_{i=1}^{n} Y_i^2 - a_0 \sum_{i=1}^{n} Y_i - a_1 \sum_{i=1}^{n} X_i Y_i$$

To successfully implement the prediction intervals, it is necessary to apply the appropriate parameters for each of the subsequent forecasts. These parameters are calculated by implementing the least squares method that was discussed in earlier chapters. This means that each ne prediction interval calculation has to take into account all previous period values including the forecasts before them. For example, year 2009 interval periods use the parameters of the previous 59 period values, while year 2010 interval periods must use the previous 60 periods including the forecast for year 2009. Table 7 shows the necessary computation that need to be undergone for successful subsequent parameters estimation that is needed to achieve prediction interval results. Since the AR1 model had used the series where the price peaks and price falls were eliminated, the same series is then applied to estimate the prediction interval for pine roundwood prices.

Table 7: Sum of squares calculation table. Values for the years of 1953 until 2006 follow the same calculation pattern as those in the table

Year	Year Number (X)	Price Value (Y)	X^2	Y^2	XY
1950	1	25,71	1	661,209796	25,714
1951	2	37,82	4	1429,974225	75,63
1952	3	49,80	9	2480,338809	149,409
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
2007	58	62,65	3364	3925,0225	3633,7
2008	59	61,11	3481	3734,4321	3605,49
Totals	**1770**	**2682,48**	**70210**	**124642,50**	**83332,29**
2009	60	59,83	3600	3579,6289	3589,8
Total	**1830**	**2742,31**	**73810**	**128222,13**	**86922,09**
2010	61	58,75	3721	3451,5625	3583,75
Total	**1891**	**2801,06**	**77531**	**131673,69**	**90505,84**
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
2020	71	57,85	5041	3346,6225	4107,35
Totals	**2556**	**3380,46**	**121836**	**165244,86**	**129031,89**

Calculating the subsequent parameters with least squares estimate is done for each forecast year. These parameters serve as vital information when the prediction intervals are calculated. l Prediction intervals for year 2009 are calculated as follows:

Calculation for estimating the error sum of squares, SSE, pine roundwood prices 2009:

$$SSE = 128222{,}13 - 40{,}143 * 2742{,}31 - 0{,}1824 * 86922{,}09$$

$$SSE = 2286{,}34$$

Calculation of mean squared error, MSE, pine roundwood prices 2009:

$$MSE = \frac{2286{,}34}{60 - 1}$$

$$MSE = 38{,}75$$

Calculation of 80 % prediction interval, pine roundwood prices 2009:

$$59{,}83 \pm 1{,}282\sqrt{38{,}75} = 59{,}83 \pm 7{,}98$$

$$59{,}83 - 7{,}98 \leq 59{,}83 \leq 59{,}83 + 7{,}98$$

$$= [51{,}77; 67{,}87]$$

All the intervals for all following years are calculated in a similar manner, using appropriate corresponding parameters. Results of these intervals can be observed in table 8, where the 80% probability intervals are shown by upper and lower limits.

Table 8: AR1 forecasts and their corresponding prediction intervals

Forecast Year	AR1 Forecast	80% Prediction Interval	Upper 80% Limit	Lower 80% Limit
2009	59,82	±7,98	67,87	51,77
2010	58,75	±8	66,82	50,68
2011	57,85	±8,01	65,93	49,77
2012	57,09	±7,99	65,15	49,03
2013	56,46	±7,96	64,42	48,44
2014	55,93	±7,93	63,86	48
2015	55,48	±7,89	63,37	47,59
2016	55,09	±7,84	62,93	47,25
2017	54,77	±7,8	62,57	46,97
2018	54,49	±7,75	62,24	46,74
2019	54,25	±7,7	61,95	46,55
2020	54,05	±7,59	61,64	46,46

4 Finish forest sector economic outlook

Total commercial trade of timber in Finland in 2008 will amount to 51 mill. m³, resulting in reduction of 20 mill. m³ from the previous year's total due to the decrease in production of sawnwood and paper. General commercial tendencies in non-industrial private forests are down by 13% and by 5% in company-owned forests and forests owned by Metsähallitus. Imports of roundwood that were approximately 18 mill. m³ in previous years, are expected to end as a result of an increase in roundwood export duties from Russia. Despite the overall reduction tendencies of the roundwood market in Finland, the stocks of harvested wood are up considerably. (Hänninen & Sevola 2008, 31.)

A study undergone by the Finish Forest Research Institute in 2009, suggests a grim scenario, found in tables 9 and 10, for the future of the industry. According to the researchers the institute, the next decade will experience a considerable drop in the levels of production and consumption of all timber materials in all sectors of the forest industry. The decline predicted is constant over the next decade, as well as a constant decrease in exported roundwood. (Metla 2009.)

Table 9: Finish forest industry wood production in 2007 and outlook for 2015 and 2020, 1000m³ (Finish Forest Research Institute 2009)

	2007	2015	2020	Change 2007	VS 2020
				Quantity	%
Wood Products	14,3	11,8	11,9	-2,4	-17
Pulp	12,9	9	7,5	-5,4	-38
Paper and Paperboard	14,3	10,8	9,4	-7,9	-34

Table 10: Finish forest industry wood consumption in 2007 and outlook for 2015 and 2020, 1000m³ (Finish Forest Research Institute 2009)

	2007	2015	2020	Change 2007	VS 2020
				Quantity	%
Forest Industry Total	75,4	57,9	52,5	-22,3	-30
Domestic roundwood	59,4	49,9	46,2	-13,2	-22
Pulp Industry	53,6	38,8	33,1	-20,5	-38
Domestic roundwood	29,3	25,9	22,2	-7,1	-24
Wood Products Industry	32,7	26	26,4	-6,3	-19
Domestic roundwood	29,7	24	24,4	-5,3	-18

Finland's advanced forest industry has over the course of its history grown to large proportions, which exceed the need of its domestic markets, thus making it very dependent on exports. Some of the main export products of the forest industry include paper and pulp products, sawnwood and plywood as well as raw roundwood. The largest export markets of the Finish timber industry are the United Kingdom, Germany, and Japan that account for almost half of all exports. The dependence of the industry on exports makes it very vulnerable to any negative changes in the established value chains. According to Hetemäki and Hänninen the declining trend in the Finish forest industry sector is due to the weakening of the export markets and the competitiveness of the Finish production relative to major competing markets of Sweden, West Europe, and Asia. The decrease in exports and the overall negative tendency of the industry as argued by Hetemäki & Hänninen (2009, 1) is a result of three main factors:

1) World economic crisis and its affect on the construction and housing markets
2) End of Russian roundwood exports and forced diversification
3) Crisis in the paper and pulp industry

4.1 World Economic Crisis

The first and the main factor that had influenced negatively on Finish forest industry is the recent world economic crisis that originated in the United States due to the collapse of the housing and financial markets. The effects of the crisis, the strong euro, and the rapidly rising raw material and energy prices in 2007 accompanied by high interest rates, have all pushed the euro area onto a slower growth track in 2008. GDP growth in Germany, the United Kingdom and Japan, which are the main export markets for the Finish forest industry, has weakened considerably in 2008 compared with 2007. As an effect of this economic downturn, the housing and construction markets in Western Europe have downsized comparing to previous years. This significantly impacted on sawnwood demand and its prices. The Finish market is similarly experiencing a drop in sawnwood demand as a result of the reduced level of housing construction in 2008. (Hetemäki & Hänninen 2009, 2) As stated in the yearly 2008 industry report published by Metla organization, the average yearly price of Finish sawnwood is expected to be down by about 18% in 2008, and both production and exports are expected to be down by the same percentage. This negative trend with price drops is expected to extrapolate into near future years.

Pine roundwood as well as rest of the timber species, are the main raw material for the final product which is sawnwood, and plywood. Finland’s forest industry largely depends on the production, use of and exports of sawnwood and plywood. Recorded in table 11 are the spread figures for Finland's sawnwood and plywood market in 2007. According to table 8, 57% of sawnwood and a staggering 88% of plywood, have accounted for exports in 2007. These figures are reliable evidence of Finish forest industry high dependency to the export markets of sales. Due to the decline in the housing markets in Europe, the demand for Finish sawnwood exports is expected to continue to drop by 5% in 2009 and 3% in 2010. (Hänninen & Mutanen 2008, 14.)

Table 11: The Finnish sawmilling and plywood industries 2007, 1000m³ (Finnish Forest Industries Federation and National Board of Customs 2007)

	Sawnwood	%	Plywood	%
Production	12400	100	1410	100
Domestic Use	5319	43	171	12
Exports	7081	57	1239	88

The decline in the construction seen on the Western European markets towards the end of 2007 has led to oversupply in the sawnwood market and a rapid drop in the sawnwood prices. This tendency has continued during 2008 with an even further decline in construction. In future, the pressure for a decrease in prices will focus particularly on construction sawnwood. The decreasing levels of world trade accompanying the deterioration in economic trends will create further downward pressure on the price of construction sawnwood. (Hänninen & Mutanen 2009, 15.)

The profitability of Finish sawnwood production has fallen significantly in the recent years, as a result of falling sawnwood prices and high raw material costs. The situation is similar in the Baltic countries and in central Europe. With a decrease in the sawnwood demand and prices the production has fallen significantly compared to previous years. Table 12 shows the figures for production and exports decrease for the recent years, as well as an official estimate of the Finish Forest Industry Federation for the year 2009.

Table 12: Production and exports in the sawmilling and plywood industries, 1000m³ (Finnish Forest Industries Federation and National Board of Customs 2009)

	Production			Exports		
	2007	2008	2009	2007	2008	2009

Sawnwood	12400	9900	9800	7081	5800	5600
% Change	2	-20	-1	-8	-18	-3
Plywood	1410	1350	1280	1239	1170	1110
%Change	0	-4	-5	-1	-6	-5

The extremely high dependency of Finland to the export markets is a negative factor at the moment, however if something favorable to the Finish products was to occur in those markets of sale, it would cause positive outcome on the Finish forest industry. Even though the real chances of something so big happening that it would have the power of changing the whole fundamental course are quite low, nevertheless it is important to keep track of all the minor aspects.

In the case of the high dependency on exports, some of the triggers that can influence the industry are listed below.

- Change in the construction and housing markets of Western Europe. Whether these markets will continue to decline or in case if they start to boom, will decide their effect on the Finish industry.

- Exchange rate of euro against the rates of main competitor's currencies. Since the main competition is seen from Sweden and Canada, the two countries with their own currencies, the future exchange rate against their currencies will dictate buyer's preferences. A strong Euro is unfavorable to the Finish forest industry, as for the same money it is possible to purchase more materials from competitors.

- Governmental taxation decisions in Finland and the competitors countries. Anticipated partial reliefs of taxation on exports from Finland to countries like China and Japan would better the industry's situation. Similarly any changes in competitors markets would have according effects.

- Changes in GDP of Finland as well as all other countries involved in trade of timber assortments.

4.2 Forced Diversification Due to End of Russian Roundwood Imports

For many years now, even though Finland's forest resources are abundant, the Finish forest industry's roundwood procurement has consisted largely of imported roundwood. Imports that were almost fully dependant from Russian timber, have accounted for about 25% of total roundwood procurement in Finland on a yearly basis. Due to the Russian government implementing a high export charge to all raw timber materials, the import of Russian roundwood to Finland will cease to exist starting from 2009, when export charges will sky-high to 50 Euros per m^3. Though Finish roundwood resources are easily sufficient to replace the imported Russian pine, there will be scarcity of spruce and domestic birch will only be able to replace a portion of imports. As a part of the process of adjusting and reorganizing, the industry has begun to replace the imported birch with domestic pine. (Hänninen & Sevola 2008, 30.)

The decision to introduce a programme that would raise roundwood export duties was announced by the Russian government in the early 2007, and the results of these increases are that it would no longer be financially viable to import Russian roundwood. The aim of these export duties is to allow Russia's own forest industry to develop and raise the proportion of value added products. This long anticipated change in the Russian customs legislation could not have come at a worse time for the importers of Russian roundwood, than at the peak of the economic crisis. By 2009, the Finish forest industry will be struck by both the lowering production rates and the need to diversify the industry in order to adapt to the changes in the value chain.

Russia's decision to raise export duties on its roundwood causing almost complete halt in the exports of raw timber will have as significant impact on the operating environment of the Finish forest industry. The impositions on the duties increase will lead to considerable changes in the Finish forest industry's roundwood procurement. Finding alternative sources of raw materials may be difficult causing further cuts in production capacity. However, the absence of the Russian roundwood exports, and especially the softwood sawlogs, will decrease the raw material availability not only in Finland, but in all markets of previous interest, particularly China and Japan. This will reduce the world supply of sawnwood substantially and could actually raise sawnwood prices by more than anticipated. This would have a favorable impact on the profitably of the Finish wood products industry, however for the Finish paper and pulp industry that mainly depends on birch roundwood, the Russian decision on roundwood export duties will have purely negative effects. (Hänninen & Sevola 2009, 7.)

The Finish forest industry has historically been dependant on imported roundwood that has partially replaced the domestic product. This process has formed itself due to the domestic procurement being much more expensive than importing ready roundwood at a considerably cheap price. Table 13 displays the total figures for roundwood imports by countries to Finland, and as it is obvious from the data represented here, the largest seller of roundwood to Finland is the Russian Federation with about 66.1% share.

Table 13: Total import of roundwood by country 2004 – 2007, in 1000m³ (Finish Statistical Yearbook of Forestry 2008, 339)

Year	Russia	Latvia	Sweden	Estonia	Uruguay	Lithuania	Germany	UK	Belarus	Total
2004	14071	1108	217	1300	206	129	68	382	5	17485
2005	17010	1470	749	1214	253	166	119	395	59	21468
2006	15634	1529	524	1128	342	200	160	414	23	19993
2007	12007	1657	1442	1052	583	387	353	334	0	18165
Share (%)	**66,1**	**9,1**	**7,9**	**5,8**	**3,2**	**2,1**	**1,9**	**1,8**	**0**	**100**

Table 14 displays the historically recorded data for pine roundwood imports to Finland, from which it is obvious, that the import pine roundwood import has been escalating throughout the past 15 years. In table 14 another clue can be observed that could hypothetically be repeated in the future. During the years of 1991 until 1993, when Russian Federation was going through a difficult period of internal changes, the imports were on a minimum historical level. In 2009 when the export duties do go into effect, it is almost certain that the pine roundwood imports to Finland will drop to a minimum similar to that recorded during 1991 to 1993.

Table 14: Imports of pine roundwood 1965 – 2007, in 1000m³ (Finish Statistical Yearbook of Forestry 2008, 337)

Year	Pine Logs 1000m³	Year	Pine Logs 1000m³	Year	Pine Logs 1000m³	Year	Pine Logs 1000m³	Year	Pine Logs 1000m³
1 965	585	1 975	569	1 985	350	1 995	218	2 005	1666
1 966	644	1 976	458	1 986	320	1 996	281	2 006	1393

1 967	564	1 977	560	1 987	273	1 997	420	2 007	944
1 968	552	1 978	509	1 988	231	1 998	514		
1 969	349	1 979	450	1 989	194	1 999	586		
1 970	494	1 980	507	1 990	183	2 000	805		
1 971	490	1 981	386	1 991	114	2 001	1099		
1 972	597	1 982	378	1992	58	2002	1532		
1 973	485	1 983	335	1993	47	2003	1619		
1 974	778	1 984	331	1 994	147	2004	1780		

A very negative effect for the forest industry is that not only the imports of pine roundwood will cease to exist in 2009, but it is uncertain for how long. During 1991 until 1993 when there was a scarcity of Russian roundwood on the market, there existed an uncertainty concerning the question of "When will it come back?". The traders knew that there are reforms and re-structuring happening in Russia, and that as soon as they are over the imports will come back, as they did. Compared to the past occurrence, the current changes will stay in effect for an uncertain period of time, and possibly for a long time. This forces the Finish forest industry to adapt to these changes whether they like it or not. The domestic market will be forced to go through diversification in order to adapt to the new situation. On one hand, this should actually benefit the domestic market and actually raise the prices, but the reality is that the Finish pine roundwood prices as well as the prices for the rest of the timber assortment in Finland are competitively too high compared to other countries. The price for Finish roundwood, and especially the pine roundwood will continue to fall until it reaches the competitive level of other countries that are involved in the timber trade. In the long run the absence of imports from Russia will strengthen the domestic industry's self dependency, as well as increase the domestic procurement. (Islander, A. 29.09.2009). The main negative concern at the moment is that these changes are happening at a very unfit time when they collide against many other unfavorable influences, thus making them extremely difficult to address in full extent.

4.3 Decrease in Paper and Pulp Markets

The third reason for decreasing raw timber material prices is the downturn in the paper and pulp industry of Finland. The structural change in the communication paper market is continuing, meaning that the electronic media is increasingly replacing the print media, thus declining the paper products demand and negatively affecting the price prospects. The paper producing companies are no longer just competing with each other, but are now heading in direct competition with the electronic media. As a result the pricing power of the paper companies has weakened considerably and is expected to decline further in the next decade. In addition to the current problems of the industry, the increasing supply of paper products from Asia and particularly China, to the Western markets has increased the competition even further, pushing the dealers to reconsider their price strategies.

The paper industry's output capacity has substantially decreased with many mills closed in Finland and elsewhere in Europe, as a result of oversupply of the market and weak trend in prices. The significant reduction in GDP growth and the weakening demand for paper products have lead the Finish forest industry corporations to announce further closures of production facilities and machines during autumn of 2008. Local economy was hit with negative downturns, leaving many thousands of people workless. With these substantial cuts in the production capacities and lower demand, Finland's production and exports are expected to be down by about 4% for the full year in 2009. (Hänninen & Sevola 2009, 23.)

4.4 Historical Events Powerful Enough to Affect the Price

Throughout the historical time-series of pine roundwood prices, it can be easily noticed that the price has experienced some turbulences that caused spikes in its development. At some points the price jumped to record highs and at other it dropped to record lows. One of the first recorded high spikes was during the year 1950 to 1953, and the cause of such extreme price jump at that time was the Korean War during which Finish timber was in demand by the Asian market thus generating the growth of price.

Other historically important events such as the oil crisis of 1973 that has caused the prices for timber to jump sky high to record values, and events like the breakdown of the Soviet Union in 1991 that lead to a halt in trade between Finland and the Russian Federation for years, are all good examples of higher power effects on the price. These events even though they are rare they are sometimes inevitable. They always affect the business markets of the countries involved. Their outcome effects whether negative or positive on the price can be logically judged and interpreted. In case of a possibility of a large scale occurrence that is powerful enough to affect the Finish market, one must try to understand the root of the problem and it effects on the price of the products.

4.5 Summary of Industrial Outlook Effects

In the course of evaluating the general situation in the Finish forestry market, it was evident from all sources that the overall tendencies are worsening in an unfavorable direction of the industry. As table 15 suggests, all sectors of the industry are experiencing very noticeable decreases in their capacities. The AR1 forecast for pine roundwood price development created in the earlier chapters is supported by the general views of the Finish Forest Research Institute that are summarized in the yearly report. Just as the AR1 forecast of this study suggests that the future development of the pine roundwood price is expected to continue to decline steadily in the next decade, so does the general opinion of the FFRI conclude that the deterioration of the pine roundwood price along with the rests of timber assortments, excluding birch, will continue on a negative course.

Table 15: Outlook on change in main sectors of the Finish forest industry (Metla 2009)

Forest Industry's	2007	2008	2009
Variables	% change	% change	% change
Sawnwood Production	2	-20	-1
Sawnwood Export	-8	-18	-3
Sawnwood Price	23	-18	-3
Paper Production	1	-6	-4
Paper Export	1	-6	-4
Paper Export Price	-2	1	0
Commercial Fellings	13	-12	1
Roundwood Imports	-9	4	-40
Sawlog Prices			
Pine	34	-12	-5
Spruce	33	-15	-5
Birch	10	3	0
Pulpwood Prices			
Pine	23	2	-1
Spruce	11	-9	-1
Birch	21	2	6

As it was established for the industry overlook, there exist three highly noticeable reasons to the pine roundwood price deterioration. These factors influencing the price through any altering changes within their fields may serve as general indicators to the industry's future situation. This suggests that any new differences (whether positive or not) may allow to generally evaluate their impact on the industry and conclude whether they are for the better or not.

5 Expert's opinions and their collection

As it was mentioned at the beginning, this study will implement two data sources to achieve final results. This chapter is dedicated to the collection and analysis of the second data source, the expert opinions in the field of business interest.

5.1.1 Data gathering

The primary data for this study was gathered through five personal interviews with the experts in the field of forestry resources of Finland. Interviews are one of the most beneficial primary data gathering sources for a qualitative research of any sort. Interviews allow to gather rich data from people dedicated to working in a specific field who have the knowledge in the topic of research (Myers 2009,121). Each interview focused on discussing one product, the pine roundwood assortment and its price development during the next decade. Interviews were conducted in two cities of Finland, Helsinki and Vantaa, during the months of September and October of 2009.

5.1.2 Sample Identification

The sample selection process for the qualitative data gathering of this study is referred to as the non-probability sampling type, which is sampling based not on a random probability but on pre-selected types of samples. The form of the non-probability sampling implemented is the purposeful sampling, one of the most widely used sampling techniques in qualitative researches. Purposeful sampling is based on the assumption that the investigator wants to discover, understand, and gain insight and therefore must select a sample from which the most can be learned. (Merriam 1998, 61.) Widening the understanding, gaining professional insight, and achieving deeper knowledge are the main focus aspects for conducting the qualitative research in this study, thus purposeful sampling criteria was applied during the interviewee's selection process.

5.1.3 Sampling Criteria

To begin the purposive sampling that would best fit the interests of this study, the general selection criteria were established for people to be interviewed. The people who posed most value to generating a successful overview of the future pine roundwood price development would all need to posses special characteristics that would serve the purposes of this study. Such characteristics criteria of this study for selecting appropriate experts include:

- Area of expertise: Forestry and forestry statistics are the desirable fields of expertise
- Association to an organization whose only interests are in Finish forestry
- Position or a post within an organization that is specifically focused on Finish forestry, it's resources, and markets of industry
- Possible involvement with a research team responsible for analyzing the Finish forestry sector

The respondents that were selected all belong to forest research organizations of Finland. All in all, there exist four major forest research organizations that are dedicated to researching and publishing information concerning forestry resources of Finland.

- Finish Forest Research Institute (Metla, FFRI)- Official representative of the Agriculture and Forestry Ministry of Finland
- Finish Forest Industries Federation (Metsäteollisuus, FFIF)- Official representative organization of the forest industry sector comprised from members of companies working the forestry industry
- Finish Forest Association (FFA) – Representative of the Finish forest owners and forest related organization
- European Forest Institute (EFI)

All the above mentioned organizations are representatives of three major focus groups in the forestry sector of Finland. The groups these organizations represent are the three main regulators of price for forest products in Finland. They are the government, in the face of the Agricultural and Forestry Ministry, the business sector, represented by the Finish Forest Industries Federation, and the forest owners represented by the Finish Forest Association.

5.1.4 Established Samples

The interviewees who were selected by the author of this study were all fit acording to the set sampling criteria and the requirements of the expertise field. Respondents from all institutions set in the sample criteria were possible to interview. Since some of the interviewees prefered not to be quoated directly and didn't wish for their name to appear in this study, the study will from here on refer to the respondents by assigning them codes. Since there were five interviewees, the codes will range from R1 to R5.

5.1.5 Interviewing process

The data gathering conducted through structured interviews, that used pre-formulated questions that were strictly regulated with regard to the order and the time available (Myers 2009, 124) The aim of the interviews was to receive specific answers for specific questions that posed the most value for this research. For that reason, the wording of the questions was predetermined, as well as the order according to which they were asked was also predetermined.

The interviewing process overall took a form of an oral survey, where the respondents would verbally answer the questions that were recorded by the interviewer. (see Merriam 1998, 73.)

The conducted interviews were open in their nature. This refers to the type of questions that were asked as well as the fact that the interviews followed the leads given by the respondents during the discussion (see Valtonen 2000, 24). The questions that interested the researcher were of a very specific field of interest and of a very narrow specialization, thus not all the respondents were able to react to them equally. Even though all the interviewees were asked the same questions, their answers varied in form. Some respondents were able to give very precise answers, while other elaborated on the subject as a whole due to their lack of knowledge in statistical information. If an interviewee was at any point of time troubled to come up with a precise answer, he/she were asked to elaborate their own opinion in any way they felt was fit, thus placing the respondents in a much more relaxed situation where they would give out more needed information.

The interviews took place in two cities of Finland, they were Helsinki and Vantaa. Three out of five interviews were face to face interviews and the other two were telephone interviews. All interviews were recorded on paper in the form of notes that were then used later in the study. The face to face interviews lasted 15 to 20 minutes long while telephone interviews lasted under 10 minutes.

The conducted interview sessions have proceeded in the following way. First, the interviewees were informed about the product in question, which was the pine roundwood assortment, followed by informing the participants that the focus of the discussion will be about the price of this product, and their opinions of its future development. After introducing the topic, all participants were familiarized with current price for the pine roundwood in Euros, as well as some major records of previous years. Before asking the more direct questions that dealt with exactly with the price, all participants were asked two open ended questions the aim of which was to receive general information on the product and to lead the interviewees into a discussion. These first questions aimed at finding out the key elements of price formation of the pine roundwood, as well as establishing the main forces behind price formation. (see Apendix 1.)

The second type of questions aimed directly on establishing the pine roundwood price development, and focused only on information relevant to the pricing of the product. Such questions included inquiries on the opinions of expert concerning what the price might be during years of 2010, 2015, and 2020, as well as opinions of participants concerning the minimum and maximum values in the next decade. Participants were also asked a question which involved using a scale of 1 to 10. The question was, ”On a scale of 1 to 10, please rate the possibility of a price peak and the possibility of a price drop occurring within the next decade, years 2010 until 2020”.

5.2 Data recording and Data Analysis

During the data analysis of this study, three steps were used. In the first step, which is the **data reduction,** the interviews were analyzed as separate individual cases. This enabled to achieve a fuller understanding of each case separately, as all respondents had individual understanding on the topic and gave their answer in different forms. For example some respondents preferred to talk in percentage scale while others could operate in currency.

The second step which is **data display,** the cases were recorded and compared against each other. The collected data from each case did not compete with others, but each case has rather widened the understanding as a whole and contributed to the overall understanding. Data was recorded and represented by tables, where it either took a numeral or a text form. (see Ghauri & Grönhaug 2005, 208.) Finally the third step was to draw the **conclusions** of the data and visually present the qualitative data on the previously quantitatively obtained results.

5.3 Validity and Reliability

Validity is a measure of truthfulness and the quality of the research being used for supporting the argument made. The validity of a study refers to the *proper use of concepts* along the study, *consistency between objectives*, the *methods* used, and the *conclusions* made from the study at the end. As a whole, validity measures how well the research really studies the topic that was set at the beginning. (Bryman & Bell 2003, 76.)

The degree of validity in this study can be considered high. To achieve the desired validity factor in this study, several certain measures were kept in mind that influenced the outcome. First, the research questions were formulated and later corrected, that were concrete enough to be answered. Second, the theory was selected on the grounds of being most suitable for the research objective and research questions. Third, the interview questions were formulated based on the desirable information that could be linked to the theoretically obtained results. Finally the data was analyzed and structured in a way that all the sub research question were answered and the conclusions gave the answer for the main research question.

Reliability of a study on the other hand is the consistency to which the result is achieved. This means that the results of a study are repeatable when certain measures are executed in exact manner. A reliable research must yield same results if it would be done over again. There are three parameter factors for measuring reliability in a research. These are *stability*, *internal reliability* and *inter-observer consistency*. (Bryman & Bell 2003, 76.)

The inter-observer factor deals with consistency among several authors and researchers, and is only a applicable to studies created by more than one author, thus this parameter can be safely avoided for the purposes of this research. The stability factor answers for the stability of the study's results over a period of time. As this study deals with the topic of forecasting over long-term, it can hardly be said that the outcomes will stay stable over the course of time. Therefore it must be recognized that the study is reliable in the situation and the environment during which the study was made. The internal reliability of this study can be divided into two parts just like the study itself. The quantitative part of the study can be said to be highly reliable, as it follows a certain mathematical process explained by theory, and if it would be repeated the outcomes would be exactly the same. The second part which is the qualitative section can be said to be of medium reliability measure. The collected information here only gives a general opinion that the experts have at the moment. This opinion can be highly fragile and prompt to change in time, thus if the process would be repeated over a period of time, the results might differ drastically. (see Bryman & Bell 2003, 77.)

5.4 Interview Results

This chapter presents the findings of the empirical research. Each interview question will be analyzed separately and the opinions of the experts recorded and compared accordingly. The analysis will be structured so that under each question that was asked from the interviewees will be recorded all the answers of all respondents. This will allow focusing on one point of interest at a time.

Table 16: Interview question one with responses from the each respondent

Respondent	**Q1:** *What are the key elements/factors in pine roundwood price formation in Finland?*
1	At the moment the most influencing factor in pine price formation is the **demand** for the timber commodity. More demand means higher the price, less demand
2	**Exports** of pine end products from Finland. The exports are at the moment dictating the price, they are a large portion of the market and all their changes affect the price
3	**Supply** against the **demand**. Demand influences the readiness of the suppliers to negotiate the price
4	**Demand** for the pine product is low in all categories of final goods. It forces the price the most now
5	The **exports** are down and influencing the price that why the **demand** for pine is so low compared to before that it is the main factor that influences the price

Through the first interview question presented in Table 16, it can be concluded that there are several key elements that influence the pine roundwood price formation in Finland. Such elements are the supply and demand for the pine roundwood as well as the export amount. Due to recent decrease in export of pine roundwood the demand for the commodity has fallen as well, thus lowering the price and the bargaining power of the suppliers. Changes in these two currently crucial elements will dictate the future direction of the price for pine roundwood.

Table 17: Interview question two with responses from the each respondent

Respondent	**Q2:** *What are the main forces responsible for pine roundwood price formation in Finland?*
1	**Paper and Pulp** industry is the main consumer of pine. It has the greatest influence
2	**Paper and Pulp** industry uses much pine and are involved in price setting and the **Construction** market also uses pine
3	**Paper and Pulp** industry is now pushing the price down due to low demand of their product, but the **Energy Sector** is now using more and more pine and will continue to grow so it is the new price setter soon
4	**Paper and Pulp** industry was always the main force for pine price, but now also the **Energy Sector** is coming into the picture. Soon the energy sector will grow
5	The main force is the demand like was said

In interview question two presented in Table 17 it can be concluded that there are three main industry sectors that have the most responsibility for pine roundwood price formation in Finland. These are the paper and pulp sector, the construction sector, and the energy sector. All three are large consumers of pine roundwood thus all changes in their needs for raw material have a direct influence on the price of pine roundwood in Finland. Unlike the energy sector that is steadily increasing its volumes of consumption thus forcing the increase of price, the paper and pulp and the construction sectors are displaying dramatic decreases in consumption volumes and are the main forces responsible for the decrease in the price.

Table 18: Interview question three with responses from the each respondent

Respondent	**Q3:** *What will in your opinion the price for pine roundwood going to be in 2010, 2015, and 2020?*
1	Hopefully **steady** until 2015, and hopefully increase after that
2	**Decrease** by about 15%to 20% until 2015, and **steady growth** after that
3	Compared to the price now, the 2020 price will be higher
4	Did not wish to comment
5	Did not wish to comment

In interview question three presented in Table 18 the initial goal was to receive concrete values of prices as responses from the interviewees. However turned out somewhat difficult for some of the respondents to give any concrete values, and others refused to speculate on the future. Instead of forcing the interviewees to speculate, it was decided to rephrase the question in such a way that the respondent could give any opinion on their view of pine roundwood price development through the next decade. Through this change, it was possible to get some responses concerning the price directions in the next ten years. Though there were few results, the ones that were collected suggest there will be a period of stagnation until the year of 2015 with even a possible further decrease. However the following half of the next decade suggests an increase and steady growth.

Table 19: Interview question four with responses from the each respondent

Respondent	**Q4:** *What is the absolute minimum price and absolute maximum price for pine roundwood in the next decade?*
1	About **40** minimum and **90** maximum
2	**50** minimum and **70** maximum
3	About **45** minimum and **75** maximum
4	Did not wish to comment
5	Did not wish to comment

The goal of interview question four in Table 19 was to establish a range of minimum and maximum price for pine roundwood throughout the next decade. Similarly to question three, some interviewees were unable to give any quantifiable solid answers. From the collected responses it can be concluded that the absolute minimum price in the next decade could be 40 Euros per 1000m³, while the absolute maximum can jump to as high as 90 Euros per 1000m³. These are of course the absolute extremes; most of other responses suggested a much narrower range as is shown in Table 19.

Table 20: Interview question four with responses from the each respondent

Respondent	**Q5:** *What is the probability on a scale of 1 to 10, of a price peak occurring within the next decade? And a price drop?*
1	**8** for a price peak, **6** for a price drop
2	**7** for price peak, **7** for price drop
3	**9** for price peak, **6** for price drop
4	Preferred to comment that ‘’there is a high chance for both
5	Did not wish to comment

By interview question five presented in Table 20, it can be concluded that there is a very high probability of a price peak occurring in the next decade. The general opinion concerning a price peak was that there will be an occurrence of such during the following ten years and it might be similar to a peak recorded in the year 2007. The probability percentage can be calculated by adding the figures given by the respondents and then taking their percentage value compared to the maximum possible probability. In Table 20 there are only three sets of answers that can be used to establish the probability. The price peak occurrence is calculated by adding the results from Table 20 (8+7+9=24) and then taking a percentage ratio from the maximum (30). The probability of a price peak occurring is 80%, and the probability of a price drop is calculated in a similar manner. The probability of a price drop was a bit smaller then of the peaks, but nevertheless it was quite high with about 63% occurrence chance. Based on these general feelings it is obvious to expect both extremes to take place sometime during the years of 2010 until 2020, but based on previous questions the peak is expected to occur in the second part of the decade while the drop in the price has a higher chance to occur in the first.

6 Discussion

This chapter is dedicated to summarizing the results of the whole study, as well as giving the conclusions and recommendations based on the research outcomes.

6.1 Summary of the Study

As a whole, the research process was successful. The study began with the identification of the research question, which was ''What is the forecast for pine roundwood commodity price until 2020?'' The main research question then gave birth to the second research question of the study ''What forecasting model is most appropriate to predicting future prices based on past values?'' Throughout the study both questions were combined in a way that one supported the other. To establish the forecast for pine roundwood and answer the main research question, theory on quantitative forecast calculation was used. The theoretical framework implemented has in its turn answered the second research question by giving a specific forecasting model that would be appropriate when forecasting the price development, which in this case was the pine roundwood price development, based on historical price values.

Table 8 (see page 30) gives the results of pine roundwood forecasts that were based on the mathematical calculation and autoregressive forecast theory. Figure 9 (see page 27) visually presents exactly same results given by table 8 with a time-series plot that shows the past pine roundwood price development as well as its forecast for the next decade until 2020. These forecasts were made possible by implementing the AR1 forecasting model, which was the main topic of research in the theoretical framework. All the forecasts made with AR1 model and the theory behind it has belonged to the quantitative method of research, and the results received were in numerical form and recorded in tables and figures. All in all the quantitative method application results proved to be what they were anticipated to be, and were of moderate and dependable accuracy.

To further investigate and to add value to the quantitative forecasts, a qualitative method of research was applied to the main research question where interviews with five experts were conducted in order to receive first hand information that is not based on just previous values, but is of the views of people working in that market. Five people were interviewed for the purposes of gathering data that could serve as vital guidance information when imagining the outlook for the pine roundwood price development. The primary information that was gathered gave different results than was originally anticipated from the industry analysis, and they are discussed in the following conclusion chapter.

6.2 Conclusions and results of the study

When the study began, it was originally planned to achieve very direct and very real values that could be used to benchmark the future price from the expert in the area of interest. Unfortunately, all the interviewed persons were unable to provide any exact values that could be quantitatively analyzed and compared with the mathematical forecasts. Based on the information collected through expert interviews, it was possible to identify several important variables of price influence and some of the ongoing trends that could be followed to predict the price development.

As it was noted by almost all respondents, the price formation of pine roundwood is most dependent on the **demand** for the product itself. It is the most crucial factor that should be considered when thinking of what the price should be at a certain time. If the general felling of the market at a time point predicts low demand, the bargaining price will be accordingly lowered as the stocked up producers of the product will be forced to sell in order to keep the current customers and not to lose them to the competitors. It is, however, the view of one of the experts (R1), that the demand for the pine roundwood will exponentially increase throughout the next decade. In his opinion the Finish forest industry will soon adapt to some of the ongoing events that have negatively affected the whole forest sector, and will continue to diversify the use of forestry products. Many other experts shared the same opinion concerning the demand aspect of pine roundwood price formation, and also added another variable of price influence which was the effect that **exports** have on price formation. Another expert (R3) mentioned that Finish forest sector is very dependent on exports, thus the price for all raw timber materials is directly correlated to the amounts of forest related products being exported from Finland. Her opinion also was that Finland will continue to be an important supplier of high quality timber products to its export markets.

Based on the experts' opinions, it was also possible to identify several current trends in the timber market, one of which has not yet been mentioned by earlier industry analysis. All the respondents were certain that the main force of pine roundwood price influence in Finland is the **Paper and Pulp** industry that is the main consumer of pine. As R1 mentioned, the paper and pulp industry is currently exhibiting a negative trend that will continue to push the price for pine roundwood down in the future. This negative trend has strong ties to previously mentioned price formation variables that are the demand and the exports. Paper and pulp industry of Finland has grown to giant size far superseding the need of the domestic market, thus very dependent on foreign markets and the demand for timber in them.

One of the experts (R2) has also strongly advised to consider the **Energy Sector** as a positive trend with force considerable enough to be put against the negative effects of the paper and pulp. The energy sector is on the rise and will be growing throughout the next decade. Its growth variables will be tied to the prices for energy products such as prices for oil and gas as well as electricity, the growth of which will only benefit the use of timber energy sources. Pine roundwood and its byproducts will be the main source of the energy sector, thus the price will be counterbalanced as other industry sectors decline. On the other hand, R3 was of the opinion that the price will be rather steady and by 2020 will be higher than it is now.

When the experts were asked to give some concrete assumptions of price in value form, none of the respondents were able to give any solid responses and some even refused to speculate on such topics. Some of them on the other hand mentioned an overall opinion that prices will be experiencing negative turbulences until 2015 and will then start to grow in the second half of the next decade. The general opinion of the industry analysis has given a similar outlook for the forest industry, where the period of 2010 until 2015 was thought to be a rough patch with unstable demand and unpredictable and rather low prices fort timber products, and the period of 2015 until 2020 a period of industry stability and growth. This aspect was not considered by the forecasts provided by the AR1 forecasting model, where the general tendency of the price was a decrease throughout the whole period of the next decade. Overall the AR1 forecast can be considered to be the spread of average pine price throughout the next decade, and serves as a benchmark point for establishing a current tendency. This means that if for example a price value for pine roundwood would be taken and compared to the AR1 forecast for that period, and it would appear to be higher at that time than in the AR1 forecast, this means there are positive tendencies in effect at that moment. They can be established by considering the current demand for the product, the general feelings of the main consumer industries. If it is lower at the point of time taken compared to the AR1 forecast, then the general tendency in effect is negative, and the variables influencing it are same as those mentioned already.

The spread of prices for pine roundwood in the next decade as was noted by the interviewees came to be quite wide, with minimum of 40€ and max of 90€ per $1000m^3$. Even though the maximum price didn't yield any particular stable results, the minimum level was thought to be quite same by all the respondents, and 40€ being the very worst imaginable scenario. The AR1 model forecasts are all predicted to lie within the 50€ to 60€ region, and this range is considered to be the safe risk average zone of price, and it is quite sure that the price will however vary, but on average will stay within the safe interval of 50€ to 60€.

Based on the interviews it was also possible to get an idea of how certainly a price peak and a price drop can occur in the next decade. Overall feeling was that a price peak will most certainly take place at some point of the next decade followed with a drop to its initial level. R2 was of an opinion that a price peak similar to that of 2007 has a very high chance of repeating itself again. It is her belief that it will happen quite surely, but will happen quickly with a fast rise and will be followed with a drop of price back to the starting point of the peak. A price drop on its own without any predeceasing rises will probably not happen. The prices are at the moment quite low, so a low drop that would set even worse records can be said to be of low risk occurrence.

To sum up the study, the AR1 model forecast represented by figure 9 and table 8 can be said to be quite reliable. The range of 80% certainty interval that is presented in figure 9 is quite accurate in describing the price for pine roundwood for the next decade. In general the range represented in figure 9 gives a good idea of the spread of the prices in the next decade. It narrows the perception down to concrete estimates that are hopefully beneficial to the user. Together with some general prognosis of the experts, the AR1 model can beneficially help with business planning for pine roundwood retailers in the next decade.

6.3 Further Research

This thesis gives grounds for further research in the topic of price forecasting. One possibility is the repetition of this study after a certain period has passed and the comparison of the two studies. This can show how accurate the initial forecasts are compared to those done in the future. Second possibility of further research is the application of the forecasting method to other timber commodities such as spruce, birch and all the pulpwood species. Due to the lack of time, this study could not include all the timber products, the interest in their future development is however high. Another possibility is to undergo the same study using a different forecasting model, possibly a moving average model, or a more complicated autoregression order. Of course other forecasting models are also applicable and their results also comparable. Other recommendations are to use a larger interviewing sample that consists of more people dealing with the prices on a day to day basis. This will give better results at the end. Also a second round of interviews can be applied, where interviewees are given the results of the first round of all the respondents. In this way they can compare their answers to those of others. This may influence the respondents to reviews their opinions, though this might have a negative effect as well. All in all, the forecasting techniques can be used in many different ways and applied to vast amounts of studies. Whether using the model applied in this study or any other, forecasts serve as additional information that is much more helpful when it exists than when it doesn't.

Bibliography and sources

Aaker, D. A., Kumar, V. & Day, G. 1999. Essentials of marketing research. First Edition. Prentice Hall. NJ.

Aaker, D. A., Kumar V. & Day, G. 2006. Marketing research. John Wiley & Sons Inc. Hoboken, NJ.

Arsham, H. 2009. Time-Critical Decision Making for Business Administratio. URL: http://home.ubalt.edu/ntsbarsh/stat-data/Forecast.htm. Last visited 30.08.2009.

Berenson, M., Levine, D, & Krehbiel, T. 2009. Basic business statistics: concepts and applications. Pearson Education. Upper Saddle River.

Box, E. G., & Jenkins, M. G. 1970. Time Series Analysis, Forecasting and Control. Holden-Day. San Francisco, CA.

Bryman, A. & Bell, E. 2003. Business research methods. First Edition. Oxford: University Press.

Finish Forest Association. 2009. URL: http://www.forest.fi/smyforest/foresteng.nsf. Last visited 19.09.2009.

Finish Forest Industries Federation. 2009. URL: http://www.forestindustries.fi/Pages/default.aspx. Last visited 19.09.2009.

Finish Forest Research Institute. 2009. URL: http://www.metla.fi/index-en.html. Last visited 22.09.2009.

Finish National Board of Customs. 2009. URL: http://www.tulli.fi/en/finnish_customs/publications/annual_reports/index.jsp. Last visited 29.09.2009.

Finish Statistical Yearbook of Forestry. 2008. Official Statistics of Finland. Finish Forest Research Institute.

Ghauri, P. & Grönhaug, K. 2005. Research methods in business studies. A practical guide. Third Edition. Harlow: Pearson Education Limited. England.

Hetemäki, L. & Hänninen, R. 2009. Outlook for Finland's Forest Industry Production and Wood Consumtion for 20015 and 2020. URL: http://www.metla.fi/tiedotteet/2009/2009-08-03-outlook-summary-en.htm. Last visited 18.09.2009.

Hänninen, R. & Mutanen, A. 2008. Production and exports in the sawmilling and plywood industries. In: Hänninen, R. & Sevola, Y. (eds.). Finnish forest sector economic outlook 2008-2009. Finnish Forest Research Institute, p. 14-19.

Hänninen, R. & Sevola, Y. 2008. Finish Forest Sector Economic Outlook 2008 – 2009. URL: http://www.metla.fi/julkaisut/suhdannekatsaus/index-en.htm. Last visited 29.09.2009.

Islander, A. Senior Forestry Advisor, Finish Forest Industries Federation, 28.09.2009.

Kaupplehti. 2009. URL: http://www.kauppalehti.fi/5/i/etusivu/?request_ahaa_info=true. Last visited 30.08.2009.

Leskinen, P. & Kangas, J. 2001. Modeling future timber price development by using expert judgments and time-series analysis. Silva Fennica 35(1):93-102. URL: http://www.metla.fi/silvafennica/abs/sa35/sa351093.htm Last visited 25.09.2009.

Makridakis, S., Wheelwright, S. & Hyndman, R. 1998. Forecasting: Methods and applications. Third Edition. John Wiley & Sons Inc. Hoboken, NJ.

Merriam, S. B. 1998. Qualitative research and case study applications in education. San Francisco, CA.

Metla. 2009. URL: http://www.metla.fi. Last visited 30.09.2009.

Myers, M. D. 2008. Qualitative research in business and management. Sage. Thousand Oaks, CA.

Valtonen, A. 2000. Bounded pleasure: cultural approach for researching categories of pleasure foods. Helsinki School of Economics and Business. Helsinki.

Yin, R. K. 2003. Applications of case study research. Sage. Thousand Oaks, CA.

Appendix 1. Interview questions (By the Author)

• What are the key elements/factors in timber price formation

in Finland?
• Who are the main players responsible for price formation?
• What is in your opinion the price of pine going to be in 2010 2015 2020?
• Until which year will the decline in prices continue?
• What is the absolute minimum for the next decade in your opinion? Maximum?
• What is the chance on a scale of 1 to 10 of a price Peak occurring? A price fall?