Knock on wood

The relationship between macro variables and forest land return in Sweden 1996-2020

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Abstract

This thesis examines if three commonly used regions in Sweden differ in yearly forest yield over the period 1996-2020. An expression defining yearly forest yield is constructed and evaluated, together with macro economy determinants in a panel data model, using Random effects. The main findings describe how the SEK/USD exchange rate potentially has a negative effect on yearly forest yield, yet no large differences can be established between the three regions. This thesis concludes that the Swedish Central Bank's short-term interest rate has no significant influence over yearly forest yield, contrary to previous studies on forest estate market price. We also find that both Exporting price index and GDP growth have a significant effect.

Keywords: Forest Yield, Panel-data, Random Effects, Macro Variables.

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Definitions and concepts

- Hectare [ha] - 10 000 m^2. The primary measurement of land.
- $[m^3 sv]$ - cubic meter of standing volume. Unit to measure the volume of a tree, used to estimate how much available timber there exists on an estate.
- $[m^3 svb]$ - cubic meter of solid volume under bark.
- Sawlogs - wood that you make timber of.
- Pulpwood - wood that you can't make timber out of, oftentimes used for making pulp.

Acknowledgement

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1 Introduction

1.1 Background

In a world where climate change is becoming real for more and more people, investors have started to seek assets where their money can make good not only from a financial perspective, but also from a sustainable perspective. Trends have risen, such as impact investing and ESG (*Environmental, Social, and Corporate Governance*), where the money is expected to not only create profits, but also make an environmental or social difference.

With this in mind, investing in forest estates becomes a way for private investors to not only get revenue streams but also actively have impact on their own investment - something that could be more difficult when buying shares in a large, listed company. Eriksson et al. [1] investigated the motives of forest estate buyers and concluded that whilst economic motives are the biggest reason for many buyers, it also comes with other values such as recreation, a sense of owning land and other non-monetary emotions.

In light of this, little research has been done regarding the total profits of owning forest estate. Several papers, like Aronsson et al. [2] and Sundelin et al. [3], investigate what factors might affect the price levels of forest land. Price levels, however, we argue reveals only half the truth. Since forest, likewise shares, gives a "dividend" for example via felling or leasing hunting permits. Therefore, we purpose in this thesis an investigation of macro variables effect on the total profits created by owning forest estate in different regions of Sweden, see Figure 1.

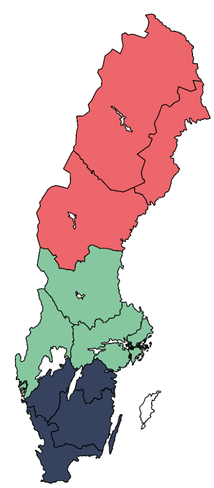

Figure 1: Regions as identified by Ludvig & Co.

1.2 Objectives

The main objectives of this thesis are to fill the gap in the literature regarding forest yield, and examine how the macro variables interest rate, exchange rate *(USD/SEK)*, export index and GDP affect the yearly forest yield. This is done in different regions, using a panel data model for Sweden as a whole, region South, region Middle and region North, as depicted in Figure 1. Following this, it will also be investigated if there are any regional differences considering the returns.

To accomplish this, it is necessary to establish a definition of yearly forest yield that represent the most vital segments of forest industry. This because, as of this date, doesn't exist any good measurements or estimations on the yearly forest yield on a macro level.

2 Literature Review

This section presents a brief review covering the current research on forest land value in Sweden, together with relevant studies on financial asset valuation and return.

We have chosen to limit our focus to Sweden, since our main objective is to provide answers on how the return on forest land can differ between regions in Sweden. But since this field is not the most researched one in Sweden, some foreign studies have also been included. It is clear that the literature on pricing is quite extensive in contrast to the one regarding return. And this study will not investigate *how* forest land is priced, instead it will be assumed that prices presented in Section 3.4 are valid. Although, substantial amount of time have been invested in reading the literature covering pricing, since we do believe that this factor is of significant value for understanding the industry as a whole.

Part of the return on any financial asset comes from the increase in price. The market price of forest estate can be analysed in numerous ways. Sundelin et al. [3] concludes that geographical location has an effect on the average price, while hauling distance and property form factor have no correlation with land valuation. Furthermore, Aronsson et al. [2] concludes with their study conducted in Canada, that micro determinants such as buyer's disposable income and seller's wealth has significant relevance. Macro level determinants effecting forest market price, which is of interest to this thesis, is more rarely discussed. According to Şukruoğlu et al. [4] interest rates, exchange rates and consumer price index are often subject for discussion when other types of investments are being analysed, such as stock market development.

In a study done by Odéen et al. [5], the authors makes an effort to find the causality between various macro level determinants and the market price of forest land. An attempt to define the return of forest land is also made, since the return most likely have a direct effect on the market price. Their conclusion is that a proper definition is to hard to specify, and no result is presented in this matter. They further conclude that global macro determinants, such as interest rates, exchange rates and GDP, play an important role in explaining the market price on forest land. They also argue that favourable tax legislation affects the market price together with the willingness to invest by foreign investors, this conclusion is being drawn from interviews with people close to the industry.

Wahlström [6] examines how macro economy variables such as GDP, interest rate, and the price of gas effects pricing on forest land i Sweden 1995 to 2012 by using a panel data model. In his panel, regions in Sweden are set to be the different units. All macro variables have significant impact on the market price. He further concludes small differences in the regions, and discusses the possibility of missing data when evaluating his own strategy. He believes that other factors not included in the study, such as hunting permits, can have significant effect on pricing.

Forest land as an investment and how well off you would have been if you did such an investment, compared to other assets, is investigated by Lusth [7]. His study is, to the best of our knowledge, the one reaching the furthest in terms of forest land return. He does thorough work in trying to define the total return in forest land estate by calculating the price increase, the income from deforestation and the cost of keeping forest land. Lusth's calculations for defining total return is robust and in many ways highly complex and he takes numerous factors into account in his calculations. The study also has a geographical dimension, three hypothetical forest land estates spread over Sweden are being compared when calculating the total return. The author concludes that forest land overall has a similar return as a Swedish stock market index over the period 1950 to 2000, 7.9 and 7.7 respectively. He also concludes that the northern estate gives a lower return than those located in middle and southern Sweden.

A similar study to Lusth's is conducted by Werner [8]. He also compares forest land return to various assets. Although, his definition of return is not as ambitious compared to Lusth's. Werner's definition of forest return includes the price increase and dividend yield. He concludes that forest land in Sweden yields a mean return of 5.7 percent. His calculations are mainly based on Lusth's previous work, and an interview with an expert working in the field. He sets the yearly dividend yield to 3 percent.

As stated above, the financial market and its assets are often investigated together with macro economic determinants. More rarely is the forest land return analysed in such manners. Hence, a strategy where determinants like those are in focus is to us the optimal way forward. The literature on forest return is quite slim, and our goal of determine an expression for forest land return seems even more relevant. We also find it necessary to include the geographical aspect since previously studied by both Sundelin et al. and Lusth found regional differences.

To summarise, the results from previous research on forest land yield is quite vague, the main focus in most studies made have been pricing. Hence, our study fills a gap in the literature and makes a contribution to the field of forest economy.

3 Data

As for this section the data will be discussed - where and how it has been collected, what assumptions that have been made, and what impact the data might come to have on our study.

3.1 Data collection

Our main sources of data was collected at Statistics Sweden, Central Bureau of Statistics *(SCB)*, Swedish Forest Agency *(Skogsstyrelsen),* Swedish Central Bank *(Riksbanken)* and Swedish Mapping, Cadastral and Land Registration Authority *(Lantmäteriet)*. All of these sources are government institutions with easily accessible data of high credibility. The time-series used have been downloaded directly from each institution's specific online service and they can be reviewed in Table 1 and Figure 2.

Our data on market price for forest properties is collected from one of Sweden's largest accounting and consulting firms in the forestry sector, Ludvig & Co. They offer various services in fields such as business development and tax planning. They consult more than 70,000 clients and employs around 1,300 people. They are also one of the largest real estate agents dealing with forest properties.

3.2 Panel data

In contrast to cross-section data, panel data do not only contain observations on n entities, but also observations at $T \geq 2$ time periods. Panel data is also called longitudinal data or cross-sectional time-series data. A formal denotation can be expressed as

$$(X_{it}, Y_{it}),\ i = 1, \ldots, n \ \text{ and } \ t = 1, \ldots, T,$$

where notation i refers to entity and t refers to the time period [9].

The data used in this study qualifies as balanced panel data, where balanced refers to the fact that all variables are observed over all entities and over all time periods, see Table 1.

Our data consists of $t = 1996, ..., 2020$ (*years*) and $i = 1, ..., 4$ (*regions*). The regions are Sweden, southern Sweden, the middle of Sweden and northern Sweden, as described in Figure 1. The total amount of observations can then be calculated using the simple formula: $t \cdot i = N$. In our study this formula translates into 25 time periods $\cdot$ 4 regions = 100 observations.

Table 1: Descriptive statistics.

Variable	Obs.	Mean	Std. Dev.	Min	Max
$\texttt{ForestYield}_{\text{SWE}}$	25	8.772	10.211	-11.02	31.53
$\texttt{ForestYield}_{\text{South}}$	25	10.092	10.107	-5.58	40.16
$\texttt{ForestYield}_{\text{Middle}}$	25	9.017	14.417	-28.22	36.69
$\texttt{ForestYield}_{\text{North}}$	25	8.212	17.808	-16.04	64.66
InterestRate	25	1.999	1.917	-0.5	6.265
ExchangeRate	25	7.912	1.098	6.497	10.326
ExportIndex	25	0.833	3.341	-4.863	7.916
GdpGrowth	25	2.289	2.330	-4.231	5.700

Source: Authors' own calculations.

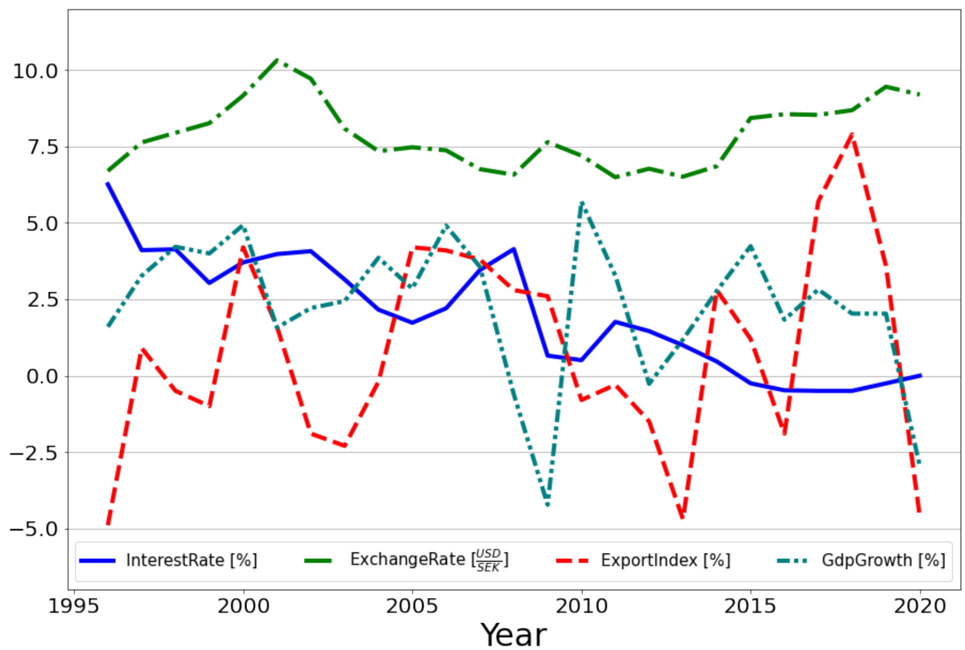

Figure 2: Time-series of explanatory variables.
Source: Swedish Central Bank and Swedish Central Bureau of Statistics.

3.3 Regions

As mentioned in Section 1.1, one of our main objectives is to provide evidence of regional differences in Sweden in terms of forest estate return. It came naturally to implement the regional sectioning constructed by Ludvig & Co since it is overlapping with the official sectioning of regions done by Swedish authorities. Figure 1 shows how Ludvig & Co defines their three main regions *(Southern, Middle and Northern)*. Southern Sweden is the most populated one, closely followed by the middle part of Sweden. The majority of larger cities in Sweden are found in these two regions, and together they represent roughly 90 percent of the population. The Northern region, on the other hand, covers almost 60 percent of Sweden's total land area, but it is only home to 10 percent of the population. There are infrastructural differences between these regions as well. As mentioned, the majority of larger cities are located in the south, which naturally causes the infrastructure to be more expanded and accessible. Major harbours and airports are found in in the south and middle parts of Sweden together with a more advanced and developed railroad network. The northern parts of Sweden is mainly rural areas with smaller cities, and the larger cities existing can be found along the coast line.

Regarding the landscape in general and the forest in particular, the different regions vary in a number of ways. Since the climate in the south is more advantageous, the southern regions contain more agricultural land than region North, thought all regions holds big internal differences. The climate also effects the composition of the forest. The north is dominated by conifer, like pine and spruce, and almost no broad-leaved trees apart from birch is to be found [10, p. 62-63]. The further south you go, the more common broad-leaved elements get, and in the south it is even possible to find pure broad-leaved forests consisting of oak, beech, aspen etc. Furthermore, the colder climate in the north makes the growth slower, creating longer cycles between planting and felling. This also makes the average age of the trees in the north higher than those in the south, as they need more time to grow big enough to log [10, p. 54].

3.4 Yearly forest yields

For calculating the yearly return on forest estate the formula

$$r_t = \frac{P_t - P_{t-1} + C_t}{P_{t-1}} \tag{1}$$

has been used, normalising each year's revenue for inflation by CPI (*Consumer Price Index*). P_t is the price for an estate in time period t and P_{t-1} for the time period $t-1$. The prices are measured in Swedish kronor per hectare $\left(\left[\frac{\text{SEK}}{\text{ha}}\right]\right)$, and they are provided by Ludvig & Co. The prices are calculated from the sum of all purchase prices divided by the sum of all the hectares that are being brokered on the open market by Ludvig & Co. This is done for Sweden as a whole but also for smaller regions of the country, as seen in Figure 1. Since Ludvig & Co are the biggest player on the market it is a reasonable assumption that this mirrors the market as a whole.

The C_t in Equation (1) represents the fixed incomes that comes from owning a forest estate, amongst others revenue from logging and leasing hunting/farming permits or weekend residences. However, in this study only revenue streams from hunting and logging are included, as for example incomes from renting weekend residences are hard to aggregate and estimate on a macro level.

For estimating the incomes of logging, the Swedish Forest Agency has been of great help. Both their database [11] and their annual statistical report covering the years 1942 to 2014. To be able to calculate the fixed incomes of forest land, several estimations had to be done.

Firstly, the Swedish log stock in assumed to consist of only spruce and pine in a 50-50 split. The Swedish Forest Agency's statistical report of 2014 shows that those two sorts of wood make up 81 percent of the total stock holding, occupying 42 percent and 39 percent respectively [10, p. 46]. As can be seen in Figure 3 this proportion has been fairly static over time.

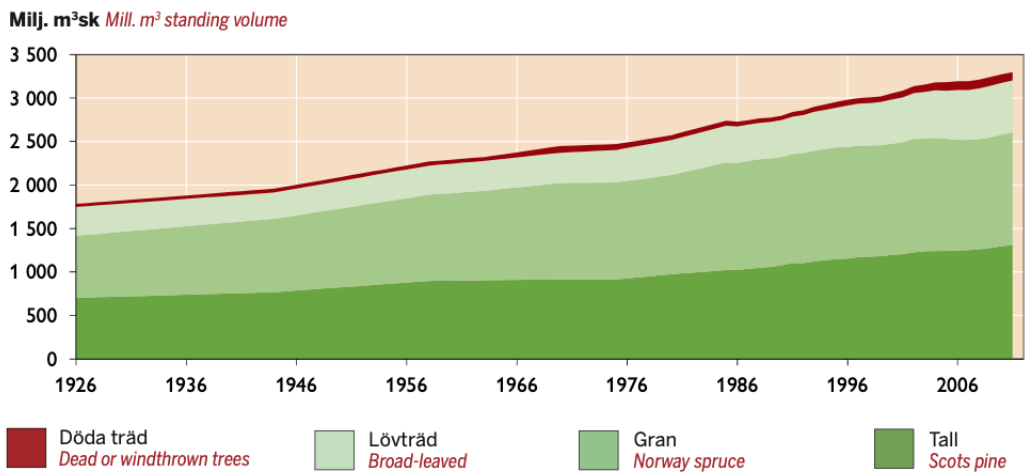

Figure 3: Trend for total standing volume in the time period 1926-2014. Moving 5-years average.
Source: Swedish Forest Agency [10, p. 66].

Secondly, it is assumed that each years' growth is being cut down. The Swedish Forest Agency's statistical report of 2014 [10, p. 58] gives a yearly site productivity for different regions. This yearly growth can then be multiplied with the fraction that make up the spruce and pine split (*i.e.* $\frac{1}{2}$), which then is multiplied with the fraction of pulpwood and sawlogs, found to be 34 percent and 40 percent respectively. The fractions of pulpwood and sawlogs have been calculated as an average from the last years gross fellings as reported in the Swedish Forest Agency's statistical report of 2014 [10, p. 167]. These fractions are then multiplied again with the prices for year t for each of these products, prices that were obtained from the Swedish Forest Agency's database [11]. Finally the conversion between m^3sv and m^3svb have been made, since the site productivity is measured in m^3sv but the output is measured in

m^3svb. All in all, this results in the logging revenue being

$$\begin{aligned} r_{\text{log},t} &= growth \cdot frac_{\text{svb/sb}} \cdot \\ \Big(frac_{\text{spur}} \big(frac_{\text{sawlog}} &\cdot P_{\text{spur sawlog},t} + frac_{\text{pulpwood}} \cdot P_{\text{spur pulpwood},t} \big) + \\ frac_{\text{pine}} \big(frac_{\text{sawlog}} &\cdot P_{\text{pine sawlog},t} + frac_{\text{pulpwood}} \cdot P_{\text{pine pulpwood},t} \big) \Big) \end{aligned} \tag{2}$$

Analysing the units of the Equation (2) yields

$$\begin{aligned} \frac{\text{SEK}}{\text{ha}} = \frac{\text{m}^3\text{sv}}{\text{ha}} \cdot \frac{\text{m}^3\text{svb}}{\text{m}^3\text{sv}} \Big(1 \big(1 \cdot \frac{\text{SEK}}{\text{m}^3\text{svb}} + 1 \cdot \frac{\text{SEK}}{\text{m}^3\text{svb}} \big) + \\ 1 \big(1 \cdot \frac{\text{SEK}}{\text{m}^3\text{svb}} + 1 \cdot \frac{\text{SEK}}{\text{m}^3\text{svb}} \big) \Big) = \frac{\text{SEK}}{\text{ha}}. \end{aligned} \tag{3}$$

Nonetheless, cutting down trees comes with a cost which must be accounted for. Some of those are directly related to the cutting itself, e.g. machines and personnel, while some are of a more indirect nature, e.g. planting new trees and maintaining roads on the estate. For the felling itself, the Swedish Forest Agency's database provides the costs as well as for the road maintenance, for large-scale forestry ($> 16,000$ ha) [11]. Sadly though, the costs for the felling are only collected in a north/south split, merging region North and South (*see* Figure 1) to one unit. The costs for road maintenance is only collected on a nationwide level. Yet, those figures were chosen to be included in the forest yield model to mirror the real life costs as accurate as possible.

On top of the costs of felling and road maintenance the costs of forest management must be accounted for - in this study limited to planting, thinning and scarification. In the Swedish Forest Agency's database, these numbers are not reported for as per m^3svb or m^3sb but rather as a price list per hectare. To be able to give a fair estimate of the costs, a percentage for each measure must be multiplied with the cost. This percentage were kindly provided by *Skogsforsk* [12]. Similarly to the costs of felling, these numbers are also only provided with the north/south split.

In total the costs could be written as

$$c_t = c_{\text{cutting},t} + c_{\text{road maintenance},t} + c_{\text{forest management},t}. \tag{4}$$

Revenue streams from leasing hunting permits have been added to incomes and costs of logging. As for data availability this area leaves much to wish for, since no regular studies are being conducted and many contracts between leaser and licensee are being treated as trade secrets. However, Sandbom [13] and Lönnqvist [14] investigated the price level as of 2004 and 2010 respectively. Those investigations combined with the Swedish Mapping, Cadastral and Land Registration Authority's mini-surveys of 2000 (*autumn*), 2003 (*spring*), 2016 (*autumn*) and 2018 (*autumn*) [15] were able to span the time period to some extent, using linear interpolation to fill the gap, see Section 3.6. As no direct costs is attributed to the leasing, our total fixed income for time t can now be written as

$$C_t = r_{\log,t} - c_t + r_{\text{hunting},t},$$

with $r_{\log,t}$ as defined in Equation (2), c_t as in Equation (4) and $r_{\text{hunting},t}$ being the income from the hunting permits.

Finally, the yearly forest yields r_t for $t = 1996, ..., 2020$ in the different regions can bee seen plotted in Figure 4. The fluctuations are mostly caused by increases or decreases in the price P_t, as the fixed incomes C_t are fairly stable and always positive over the time period. Moreover, it seems like the further north you go, the more volatility. One possible explanation could be lower liquidity - the turnover time are typically longer in the north which leads to fewer trades being made each year and hence bigger fluctuations in price. However, this is purely speculation from the authors' side.

Extremes worth mentioning includes the big downset in region Middle year 2001 and the big return for year 2005 in region North. The drop of 2001 in region Middle can be derived from a drop in the prices from $P_{2000} = 27,892 \left[\frac{\text{SEK}}{\text{ha}}\right]$ to $P_{2001} = 21,128 \left[\frac{\text{SEK}}{\text{ha}}\right]$, potentially caused by the burst of the IT bubble, with its centre in Stockholm. The big return of 2005 in region North is also caused by a price difference, here increasing from $P_{2004} = 10,989 \left[\frac{\text{SEK}}{\text{ha}}\right]$ to $P_{2005} = 16,702 \left[\frac{\text{SEK}}{\text{ha}}\right]$. There is no clear explanation for this increase but it coincides with the storm Gudrun, which makes it possible to think that the decrease in potential fellings in the southern regions made the price go up in the north.

Figure 4: The yearly forest yields as defined in Equation (1) for each region: Sweden, South, Middle and North, as defined in Figure 1.
Source: Authors' own calculations.

3.5 Independent variables

3.5.1 Swedish Central Bank's short-term interest rate

This short-term interest rate has well documented effect on the economy as a whole. According to Billmeier et al. [16], it is also standard economic theory and very common to consider this factor when analysing the return of various assets. Therefore, to include this short-term interest rate in the form of its annual average as an explanatory variable make sense. The annual average rate for this short-term interest rate was collected at the Swedish Central Bank's online statistical service, where they publish various data on interest rates, exchange rates and other macro variables. The annual average interest rate was chosen, inline with all other variables included in this study.

3.5.2 USD/SEK exchange rate

A large proportion of the production coming out of the Swedish saw mills is being exported out of the country. Roughly 75 percent of the sawed wood products, that is 18.4 million cubic meters, was exported in 2020 [17]. This export reaches numerous countries around the world. Hence, export of forest products, and export in general, is affected by exchange rates. Therefore, we have chosen to include data measuring how the Swedish currency (SEK) stands in relation to the US Dollar, (USD), since the American currency is commonly used by traders in the forest product industry [18]. In addition, the USD is one of the most traded currencies in the world [19], and could reasonably therefore be considered a variable of interest in our analysis. The annual average data for USD/SEK exchange rate were collected form the Swedish Central Bank's online statistical service.

3.5.3 Exporting price index

The Exporting price index measures the price of a basket of Swedish goods in a certain month in a certain year and compares it to the same month the year before. The annual average was calculated using data from Swedish Central Bureau of Statistics. This index gives an overview describing the current price level on exporting goods leaving Sweden. This index have an explanatory capacity since export of forest products is a vital part of the total export of goods and services. The overall price level of export products leaving Sweden is therefor a useful measure for the overall demand for Swedish goods and services.

3.5.4 GDP growth

The real mean annual GDP growth rate was also collected using data from Swedish Central Bureau of Statistics, where quarterly data is published. We then used the arithmetic mean to calculate the mean annual rate. Forest industry accounts for approximately eleven percent of the total Swedish industry, and is therefore a vital part of the total production in Sweden [17]. It is not the biggest sector but it is definitely a significant one. The GDP growth can be seen as a measure of how well

Sweden is doing as a whole and how income develops over time, on an aggregate level. GDP growth is often used in various contexts where countries are being compared to each other, or compared against themselves to track which state they are in. This measure could thus provide useful insight into the current state of the forest industry.

3.6 Missing data points

Dealing with missing data points is a science in itself. For this report, all missing data points can be deduced to the data building up the model for yearly forest yields, see Section 3.4. The missing data can be seen listed in Table 2, for each component and year.

Table 2: Missing data points for the yearly forest yields, listed by each factor and year.

Missing data	Year
Income of pine sawlogs	1996-1997
Costs of felling	1996-1997
Costs of forest management	1996-1999
Costs of road maintenance	1996-1999
Hunting permits	1996-1999, 2001-2002, 2005-2009, 2011-2015, 2017, 2019-2020

Source: Authors' own calculations.

For the missing data points of pine sawlogs, it was noticed that the fraction between pine sawlogs and pine pulpwood (*i.e.* $\frac{P_{\text{pine sawlog, t}}}{P_{\text{pine pulpwood, t}}}$ in Equation (2)) was fairly constant over the years 1998 leading up to 2005 and the storm Gudrun. See Appendix A.2 for exact values and calculations. To extrapolate the data of the years 1996-1997, an average was taken on the fraction of those years, and then multiplied with the income of pine pulpwood for the corresponding year.

Further, a similar approach was used for the extrapolation for the costs of felling, forest management and road maintenance, here using the fractions between the different factors and the total revenue from the logging (*i.e.* $\frac{c_t}{r_t}$ *as in* Equation (2) *and* Equation (4) *respectively*). See Appendix A.2 for exact values and calculations.

For the hunting permits, not really being correlated to any other of the factors, another approach had to be used. For the values laying between measurement points, simple linear interpolation was utilised to fill the gap. Same principle was also used for extrapolating the values outside the first and last studies, simply extending the linear increase/decrease outside of the study.

3.7 Expected coefficient signs

From a visual inspection of Figure 4 and Figure 2, which illustrates the yearly yields of our four regions and the yearly progress of our macro economic explanatory variables, respectively, and together with the previous research and relevant economic theory, we can determine the expected signs in our regression model. These signs can be reviewed in Table 3. Higher interest rate should decrease the return to forest land. In general, when interest increases the cost of investments increases, which then should lead to a decreasing yearly yield. The rest of our explanatory variables should have a positive effect on forest return. The export price index yields the overall price level for exported goods. An increase in price should, at least in the short run, increase the return on forest land. Since the GDP growth index could be seen as a measure of the Swedish economy as a whole, we suspect a positive effect on forest land return. The USD/SEK exchange rate directly affects the price an importer have to pay for Swedish goods. Therefore, an increase in the price of USD in terms of SEK should increase the return on forest land since Swedish goods get cheaper in real terms, thus leading to higher foreign demand for Swedish forest products.

Thus, we argue that compared to the national average, our two southern regions will have a positive effect on forest return while the northern region should display a negative relationship. This expectation is based on our data building up to the forest yearly yield variable and Section 3.3, describing the different regions and their characteristics.

Table 3: Expected signs of the independent variables.

Variable	Expected sign
`InterestRate`	-
`ExchangeRate`	+
`ExportIndex`	+
`GdpGrowth`	+
`RegionSouth`	+
`RegionMiddle`	+
`RegionNorth`	-

Source: Authors' own calculations.

4 Methodology

In the Section 3.2, a brief introduction to panel-data was given. Here we extend that discussion, and further describe the challenges existing with panel-data and what measures that has been taken to meet these challenges. This section results in our model of choice and how it was implemented on the data. A discussion regarding identification problem and methodological criticism concludes the section.

4.1 Characteristics and challenges

First and foremost, panel-data can be used to address a common problem in econometric analysis – unobserved heterogeneity. Meaning that unobserved variables that could be subject to biasing the estimation can be controlled for by using panel-data techniques [20]. A well known technique that could be considered a “standard tool” for applied econometrics is the use of a Fixed or Random effect model. Controlling for individual effects will detect differences in unobservables and observables in entities [21]. Such a model will be designed and used in our study.

As discussed in section Section 2, previous work regarding Swedish forest estate have focused on explaining the market price and/or the return in comparison to other types of financial assets. Since we aim to explain the return on forest land estate with macro determinants, our analysis have common features with previous work done on explaining stock market return. Such a study was done by Bondzie et al. [22], using panel-data covering thirteen African countries over the period 1995-2017. Their empirical approach have been used as a guiding source and similar statistical testing, assumptions, and econometric methods have been applied.

4.2 Stationarity

When analysing time-series data, which is one of the components in panel-data, one should always be considering the risk of non-stationarity. If the assumption of stationarity is violated, confidence intervals and forecasts resulting from econometric analysis can be strongly misleading [9]. Non-stationarity in time-series data will reveal itself through non-constant mean or variance and autocorrelation structure, i.e. there is a trend or breaks in the time-series. The augmented Dickey-Fuller (ADF) test is a well know statistical method used to determent if data sets are stationary or not [23]. Given that the data would be non stationary, the data needs to be transformed in some way, presumably using a first different transformation.

The null hypothesis for the augmented Dickey-Fuller test is: The examined variables are not stationary.
We reject the null hypothesis if: p-value < 0.05

4.3 Multicollinearity

When two or more explanatory variables have a precise linear relationship, perfect multicollinearity is present. Even if this perfect linear relationships is rare, some degree of correlation is most likely present between explanatory variables originated from the same field. In our case that field is macro economy, and it is reasonable to believe that some correlation exists. It is common practice to examine the correlation between explanatory variables in order to detect multicollinearity. Multicollinearity can be labelled as severe if the correlation between any two variables tested is over 0.80 or under -0.80 [24, p. 571]. This is controlled for in a cross-correlation matrix. In addition to this, we examined the Variance Inflation Factor (VIF). This measure estimates the level of variance one variable causes in another. There is no clear rule of thumb for this measure, although numbers between 5 and 10 seems to be commonly used as benchmark values [25].

4.4 Autocorrelation

If serial correlation (*i.e. autocorrelation*) exist in a linear panel-data model, it could cause the standard error to become biased and the model becomes less trustworthy. This is why serial correlation in the idiosyncratic error term, i.e. unobserved factors that impact the dependent variable, needs to be identified in panel-data models [26]. To verify whether autocorrelation exit or not, a Wooldridge test for autocorrelation in panel data is applied.

The null hypothesis for the Wooldridge test for autocorrelation in panel data is: No first-order autocorrelation.
We reject the null hypothesis if: p-value < 0.05

4.5 Heteroscedasticity

An important assumption for regression models to hold is the one assuming homoscedasticity - constant variance. Violating of the homoscedasticity assumption (*i.e heteroscedasticity*) causes in various degrees problems to the model, increasing with the level of heteroscedasticity. As in the case of autocorrelation, heteroscedasticity tends to bias the standard errors. Which in turn can lead to unreliable results in terms of regression coefficients. To test for heteroskedasticity, the Breusch-Pagan/Cook-Weisberg is applied.

The null hypothesis for the Breusch-Pagan/Cook-Weisberg test for heteroskedasticity is: Constant variance.
We reject the null hypothesis if: p-value < 0.05

4.6 Fixed or Random effect model

When handling a fixed macro-panel sample that could be considered exhaustive, such as regions in Sweden, a Fixed effect approach should be considered to be the most applicable. The Random effect approach, on the other hand, is appropriate when individuals are randomly drawn from a large population. Although, a test to conclude if the closely related Random effect model is relevant should always be conducted [20].

As discussed in section Section 4.1, panel-data models are being used to investigate individual-specific effects and/or time effects together with unobservables. These effects can either be random or fixed. In the Fixed effect model, the intercept is being investigated for variation over time and units, whilst in the Random effect model, potential differences in error variance for individuals or over time periods are being examined [23].

4.7 Hausman test

The decision rule for choosing which model to use can be expressed as follow [20]:

- $corr(X_i, a_i) = 0$ The Random effect model assumes that the individual effects a_i is **uncorrelated** with the independent variables X_i.
- $corr(X_i, a_i) \neq 0$ The Fixed effect model assumes that the individual effects a_i is **correlated** with the independent variables X_i.

Our independent variables, described in section Section 3.5, are most likely to be uncorrelated with the individual effects that could be subject to biasing our estimates. Entity characteristics such as forest quality, weather, and poaching are most likely not correlated with macro economic variables like GDP growth and exchange rates. In addition to intuitively deciding of model, there is a statistical test to be conducted. The Hausman test investigates if the individual effects are uncorrelated with the explanatory variables in the model [23].

The null hypothesis for the Hausman test is: Difference in coefficients not systematic.
Random effect model is chosen if: p-value > 0.05
Fixed effect model is chosen if: p-value < 0.05

4.8 Identification problems and methodological criticism

For our presented yearly forest yield, it must be seen as returns on a market level, since revenue from owning forest estates are more discrete than continuous in its nature. Until an estate reaches a critical size, it is simply not possible to cut down the yearly growth, but something that is needed to be done once the stock of standing volume has grown large enough.

Further, it relies on some assumptions and simplifications, such as the 50-50 spruce and pine split. Unlike a stock market index it is simply not possible to track all trades and sales being made in the forestry industry to build completely accurate models. This also reflects on the prices for sawlogs and pulpwood, which can be negotiated and hence deviate from the price obtained by the Swedish Forest Agency.

Neither are all expenses or incomes included in the model. In recent years, bio energy and bio fuel seen a big increase, this has lead to parts of the trees, such as branches, bark, tops, earlier being left in the forest now are being brought out and sold. Yet, some expenses are not included either, as no data were to be found for examplewise additional planting, fertilisation etc. Despite these shortcomings, it was decided better to include the fixed incomes in our model as it better mirrors real life incomes. Especially the revenue from hunting, which has more inter/extra-polation than true values, these figures at least depicts the true size of real life incomes.

Even if uncorrelated individual effects can be assumed in our model, one should always be concerned that some individual effects correlating with our explanatory variables exist. If such correlations exist, our model will produce inconsistent estimates and conclusions drawn can be considered to be biased. As discussed in Section 4.7, we believe that our macro economic variables are uncorrelated with regional effects. But reasonable arguments can be made, stating correlation between for example Export Price Index and individual region effects.

As discussed in section Section 3.3, we base our geographical sectioning on the work of Ludvig & Co. There might be a more appropriate sectioning that would have shown different results. It would have been interesting to dig deeper into the forest industry and divide Sweden into smaller and more specific regions than those highly aggregated once that were used. For example, northern Sweden covers a huge geographical area which intuitively should consist various types of forest estates. It would also have been interesting to isolate the big cities. Partially because they probably have huge effect on the regions as whole, but also to single out forest estates in big city areas for analysis. In addition to this, data from another country with a large forest industry would have been optimal as a control.

In Section 3.6 we discuss the method used restoring missing data. These methods are, to the best of our knowledge, highly accurate and does not cause any significant problems to the model. We do believe that our estimates represent the real, unidentified, value to a high degree. With that being said, we are humble to the fact that better methods might exist, and also to the fact the missing data points could differ from our calculated values.

More data is always better. In a perfect world we would have had access, not only to more data in terms of explanatory variables, but also to data covering a longer time period. Even if we do believe that the most significant development in forest estate return has taken place in the last two or three decades, longer times-series would have given a more presentable picture overall.

5 Results

In this section, the results obtained from statistical testing and the Random effect model regression are presented.

5.1 Stationarity

All variables were tested for stationarity at their levels. Only `ForestYield` and `GdpGrowth` was declared stationary, since no trend was detected by the augmented Dickey-Fuller test. All other variables were then transformed into their first difference and tested. At first difference, the rest of our explanatory variables were stationary. The results from the augmented Dickey-Fuller test can be reviewed below in Table 4, with index "fd" marking if first difference had to be used. All variables are showing significant p-values, concluding that the null hypothesis of non-stationarity can be rejected. Hence, non-stationarity is not a concern further on in the regression.

Augmented Dickey-Fuller test for stationarity
H_0: Data series is not stationary

Table 4: Augmented Dickey-Fuller Test for our variables, "fd" marking if first difference had to be used.

Variables	p-value	H0
`ForestYield`	0.00	Reject
`GdpGrowth`	0.00	Reject
$\texttt{InterestRate}_{\text{fd}}$	0.00	Reject
$\texttt{ExchangeRate}_{\text{fd}}$	0.00	Reject
$\texttt{ExportingIndex}_{\text{fd}}$	0.00	Reject

Source: Authors' own calculations in Stata.

5.2 Multicollinearity

The outcome from the correlation-test is presented in Table 5 below. With the decision rule discussed in Section 4.3 in mind, no correlation between any two variables over or under 0.8/-0.8, we can conclude that no sign of multicollinearity seems to be present. The same conclusion can be drawn from the VIF-test. All independent variables are close to one, significantly smaller than benchmark values stated in Section 4.3. VIF-values are presented in Table 6.

Table 5: Cross-correlation matrix of the independent variables.

Variables	(1)	(2)	(3)	(4)
`InterestRate` (1)	1.0000			
`ExchangeRate` (2)	-0.2288	1.0000		
`ExportingIndex` (3)	-0.1163	0.1964	1.0000	
`GdpGrowth` (4)	0.3302	-0.0787	0.2974	1.0000

Source: Authors' own calculations in Stata.

Table 6: Variance Inflation Factor (VIF) table of the independent variables.

	VIF	1/VIF
`InterestRate`	1.18	0.8450
`ExchangeRate`	1.12	0.8926
`ExportingIndex`	1.17	0.8582
`GdpGrowth`	1.22	0.8187
Mean VIF	1.17	

Source: Authors' own calculations in STATA.

5.3 Autocorrelation

We cannot reject the null hypothesis of the Wooldridge test for autocorrelation - no first order autocorrelation. These result tells us that there is no significant autocorrelation in the data, see Table 7. Least squares regressions assumes no autocorrelation, and the presence of autocorrelation can lead to incorrectly specified models. This result tells us the there is no significant reason to suspect that our model is incorrectly specified and no further measures needs to be taken in respect to autocorrelation.

Wooldridge test for autocorrelation in panel data
H_0: No first-order autocorrelation

5.4 Heteroskedasticity

We cannot reject the null hypothesis of constant variance on the five percent level. The result from Breusch-Pagan/Cook-Weisberg test for heteroskedasticity can be reviewed in Table 7. Since the null hypothesise is not rejected, the data can be assumed to be homoskedastic and coefficients and standard errors can be considered to be properly estimated. Thus, robust standard errors will not be used in the regression.

Breusch-Pagan/Cook-Weisberg test for heteroskedasticity
H_0: Constant variance

5.5 Hausman test

The decision rule for the Hausman test discussed in Section 4.7, gives us a clear picture of which model that should be used. The null hypothesis cannot be rejected, and a Random effect model is used. This also confirms the intuitively designed idea that Random effect model probably should be the most efficient, given our explanatory variables and how they most likely are uncorrelated with the individual effects that potentially could bias our estimates. The result of the Hausman test can be reviewed in Table 7.

Table 7: Statistical tests, results and obtained p-values of the tests.

	Wooldridge	Breusch-Pagan/Cook-Weisberg	Hausman
p-value	0.14	0.35	1.00
H_0	Do not reject	Do not reject	Do not reject

Source: Authors' own calculations in Stata.

5.6 Random effect model

The equation for our regression model contains all the variables discussed above. The results from the stationarity test led us to use the first difference for the variables: `InterestRate`, `ExchangeRate`, and `ExportingIndex`. Since the results for heteroskedasticity could not reject the null hypothesise, robust standard errors was not used in the regression. The specified equation for our Random effect model can be reviewed below in Equation (5). The `ForestYield` is the dependent variable, explained by our independent variables `InterestRate`, `ExchangeRate`, `ExportingIndex`, and `GdpGrowth`. The notation α_i represent the individual effects of the regions, and ϵ_{it} denotes the error term.

$$\begin{aligned} \texttt{ForestYield}_{it} = \beta_0 + \beta_1 \cdot \texttt{InterestRate}_t + \beta_2 \cdot \texttt{ExchangeRate}_t \, + \\ + \, \beta_3 \cdot \texttt{ExportingIndex}_t + \beta_4 \cdot \texttt{GdpGrowth}_t + \alpha_i + \epsilon_{it} \end{aligned} \tag{5}$$

The output from this regression can be reviewed in Table 8. All variables are showing significant results on different levels, except from `InterestRate` and the different regions. In addition to the coefficients, Table 8 also displays standard errors, p-values, total number of observations, N, and R^2 values.

Table 8: Estimates ($\hat{\beta}$:s), standard errors and p-values for our presented model.

	Estimate	Standard error	p-value
`InterestRate`	-1.689	1.245	0.175
`ExchangeRate`	-3.358*	1.809	0.063
`ExportingIndex`	0.889***	0.266	0.001
`GdpGrowth`	1.640***	0.585	0.005
`Intercept`	5.290*	2.888	0.067
`RegionSouth`	1.319	3.422	0.700
`RegionMiddle`	0.244	3.422	0.943
`RegionNorth`	-0.559	3.422	0.870
N	100		
R^2 Within	0.232		
R^2 Between	1.000		
R^2 overall	0.234		

$p < 0.1^{*}$, $p < 0.05^{**}$, $p < 0.01$ ***
Source: Authors' own calculations in Stata.

The Swedish Central Bank's short-term interest rate does not seem to have a significant impact in our model of forest yield. The estimated p-value of 0.175 is not significant at any of the acceptable levels in this study.In Section 6, we will discuss this result together with comparisons to previous research.

In this model, the USD/SEK exchange rate is shown to have a negative impact on the forest yield. The results are significant at the ten percent level. Compared to the other coefficients, the exchange rate has the largest impact, being twice the size of the second largest one. A one unit increase in the exchange rate gives a 3.358 percent unit decrease in yearly yield, *ceteris paribus*, meaning that if the price of USD increases in terms of SEK, the expected yearly yield decreases. This result goes against our predictions stated in Section 3.7, and this rather large and surprising impact is thoroughly discussed in Section 6.

Exporting price index appears to have a positive impact on forest yield, and it is significant on the one percent level. This index is being measured as the difference between years over time. The level of impact is quite small, a one percent unit increase in the index, gives a 0.889 percent unit increase in yearly forest yield, *ceteris paribus*. This result is in line with our predictions stated in Section 3.7.

The coefficient for GDP growth is the second largest one with significance. This estimate is significant on the one percent level. This results falls in line with our predictions (*see* Section 3.7) over how the overall movements in the economy correlate with forest yield. A one unit increase in the GDP growth rate gives a 1.640 percent unit increase in yearly forest yield, *ceteris paribus*.

One of our main interest throughout this study has been the regional aspect. We stated in Section 3.7 that regions South and Middle should have an increasing effect on forest yield and that the region North should have a decreasing power, compared to the Swedish overall average that works as reference group in the regression. Coefficients are in line with these expectations, yet the p-values does not show any statistical significance. A deeper analysis and possible explanations is given in Section 6.

The three measures for R^2 explains how much of the variance the model accounts for. The within R^2 shows how much variance the model can explain within the panel units (regions). Our results yields that 0.232 of that variance is explained by the model. The between R^2 on the other hand represent the level of variance between groups that is being accounted for in the model. For this measure we have got the estimated value of 1.000. Finally, the overall R^2 gives the total level of variance explained in the model, 0.234 in our model.

6 Discussion

This section discusses our findings in this study. The result we find the most interesting and useful is more thoroughly discussed in the beginning. The results will also be compared to previous research related to ours.

The fact that the short-term interest rate does not have a statistically significant effect on forest yield struck us as rather surprising. Previous research discussed in Section 2 gave us evidence about this type of variable having significant effect on the forest land market price. Hence, an effect on forest yields was expected. When analysing the Swedish Central Bank's short-term interest rate for the last decades, it is clear that it has been steadily decreasing and for the last couple of years it has even been negative for some time periods. We believe that the Central Bank's short-term interest rate might have lost its significance when reaching such low levels, similar conclusion is drawn by Jansson et al. [27] when analysing how the Central Bank's short-term interest rate affect investments made by Swedish firms. Previous work were the interest rate have been included have examined time periods where interest rates in general have been at a higher level. Although, the negative sign on the coefficient goes in line with previous studies that includes interest rates such as the on done by Odéen et al. [5].

The exchange rate between USD and SEK did not yield the expected result. This result was surprising to us since common economic theory predicts increase in export if the SEK depreciates against foreign currencies. This was also our initial thought, hence the expected sign. When analysing the result more in depth, we figured that forest industry must be dependent on USD/SEK exchange rate in another way than the once considered. Globally, the USD is considered to be one of the most traded currencies [19], and a lot of goods and services are priced depending on the dollar rate. With this in mind, it is reasonable to make the assumption that goods needed in the forestry industry, i.e imported goods to Sweden such as fuel, that is being priced in USD, affect the yearly forest yield more than the potential increase in export. The cost of depreciation is bigger than the benefits. It is also possible that some noise could be created by companies buying and selling timber and pulp products via futures and hence hedging against exchange fluctuations. Overall economics is complex and many factors might influence how an industry reacts to currency movements.

Both the Exporting Price Index and GDP growth variables showed the expected signs. This result clearly points towards an integrated export market, where goods and services traded out of the country are connected. We argued that this index could be a good measure for the overall demand of goods and services leaving Sweden, and the result gives evidence to that statement. Although, an excessive increase in price level are most likely to cause a decrease in demand of Swedish goods. Such a spike is not present in the data but could be considered when analysing the yearly forest yield. We suspected that an increase in GDP growth should relate to increase in forest yield, since an increase as such potentially reflects on the well being of Sweden's economy as a whole. The result gives evidence to this theory, stating that if Sweden is doing well overall, the forest industry and its investors will benefit. The positive relationship between GDP and yearly forest yield concluded by us, is in line with the conclusion made by Wahlström [6], which is that GDP increase affects market price positively.

When visually reviewing the regional yearly yield, presented in Section 3.4, large differences is not present, and the means are fairly close to each other. We were still expecting to see some impacts from the regional dummy used in the regression, which could not be found. These expectations were possible caused by big regional differences terms of market price (*i.e* $\left[\frac{\text{SEK}}{\text{ha}}\right]$). However, that is not how returns on investments are measured - a stakeholder only cares about the possible percentage yield (*and possibly some risk*) when choosing which object to bet their money on. The difference is that a fixed amount of money only would give you a larger estate in the northern parts of Sweden than in the more southern parts, yet seemingly the same return. This is in line with the soft Efficient Market Hypothesis (*EMH*), stating that different investment options with similar risk should yield roughly the same return.

The regional differences in yield concluded by Lusth [7] could not be confirmed in our study. From just observing the average return, we can conclude that northern Sweden has the lowest return. This is in line with Lusth's work, but it is not statistically confirmed in our regression model. Sundelin et al. [3] concludes that geographical location has an effect on the market price. But as discussed above, market price cannot be the only factor to consider when analysing the return of an investment. We do not reject the result of Sundelin et al. study, but when talking in terms of yearly yield on forest estate, geographical location does not seem to have as much of an impact.

This leads us to our thoughts about the model and the method used. We do not believe that the model itself is heavily misspecified. Statistical testing conducted clearly pointed us towards the Random effect model and precautions were taken regarding our data for explanatory variables. We do believe, on the other hand, that more region specific data, especially as explanatory variables, could have revealed different results and perhaps contributed to better such. We suggest that further research on this subject focusing on finding region specific data that could be use in analysing our definition of yearly forest yield.

7 Conclusion

Our main objective with this thesis was to derive a better measure for yearly forest yield than currently exists. We also wanted to investigate if there were any regional differences in this yearly yield. We processed data from multiple sources, such as the Swedish Forest Agency and Ludvig & Co, to formulate our dependent variable. An expression for yearly forest yield was designed and then assigned to regions established by Ludvig & Co. Macro economy variables were chosen to fit the regression, based on literature from previous research on forest land market price, together with research done on valuation on financial assets. The times-series data were collected from Swedish government institutions. All variables where statistically tested, and a Random effect model was used for our regression analysis, based on the Hausman test for panel data. The estimated results point towards small but insignificant regional differences. The other explanatory variables used did show significant results, apart from the interest rate. Most interesting was the negative impact USD/SEK exchange rate had on yearly forest yield. We concluded that this was due to price increase in goods and services used in forest industry production.

For further research, we suggest an even more regional specific approach. Variables that could differ between regions such as disposable income, characteristics of the owner, and taxation would be interesting to include. A study including more countries would also be of interest, since this could reveal what differences there might be on both regional and national level.

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A Appendix

A.1 Map

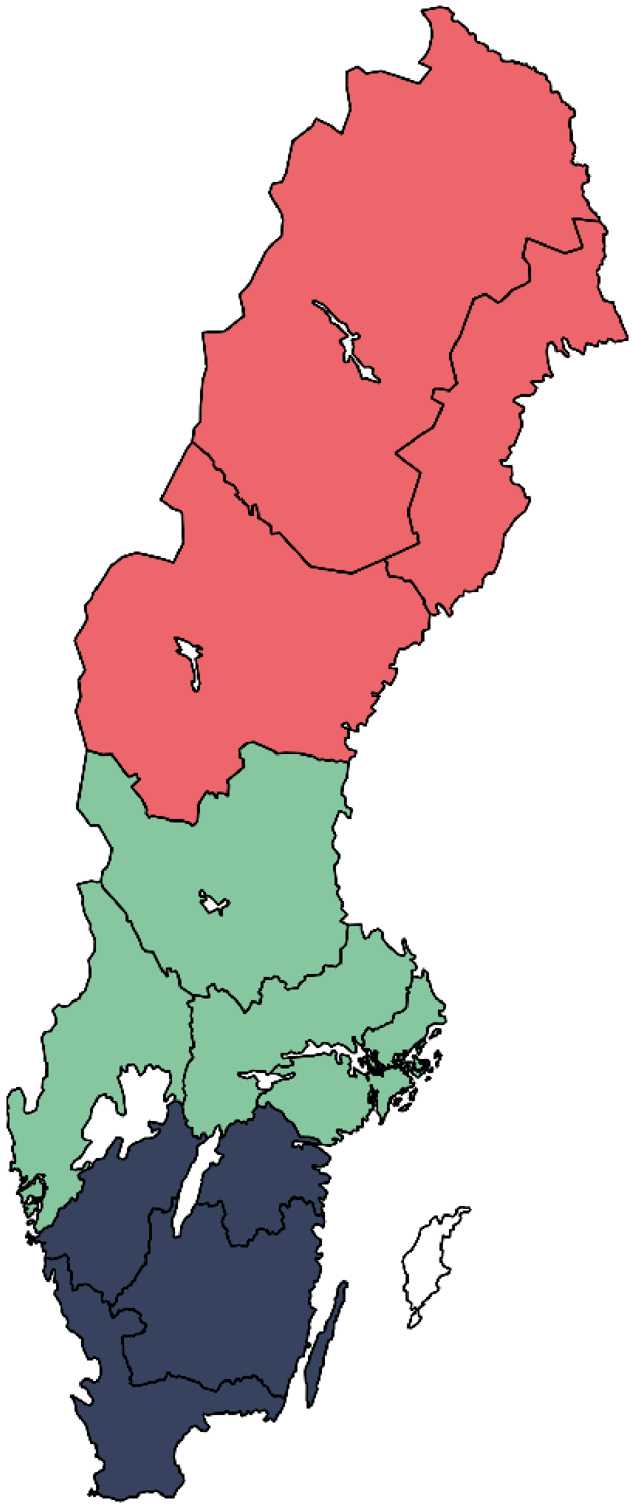

Figure 5: Ludvig & Co's sectioning of Southern, Middle and Northern Sweden.

A.2 Missing data extra-/inter-polation

Table 9: Extrapolation of revenue from pine sawlogs.

(a) Region Sweden

Year	$\frac{P_{\text{pine sawlog, t}}}{P_{\text{pine pulpwood, t}}}$
1998	2.3187963
1999	2.4404678
2000	2.1181264
2001	1.9193480
2002	1.9851372
2003	1.9352103
2004	1.8920655
Average	2.0870217

(b) Region South

Year	$\frac{P_{\text{pine sawlog, t}}}{P_{\text{pine pulpwood, t}}}$
1998	2.31879630
1999	2.44046785
2000	2.11812648
2001	1.91934799
2002	1.98513729
2003	1.93521037
2004	1.89206551
Average	2.08702168

(c) Region Middle

Year	$\frac{P_{\text{pine sawlog, t}}}{P_{\text{pine pulpwood, t}}}$
1998	2.424533374
1999	2.648193083
2000	2.472497995
2001	2.29024663
2002	2.371651644
2003	2.306740644
2004	2.221489754
Average	2.390764732

(d) Region North

Year	$\frac{P_{\text{pine sawlog, t}}}{P_{\text{pine pulpwood, t}}}$
1998	2.445196111
1999	2.637227219
2000	2.580089333
2001	2.523477335
2002	2.407944638
2003	2.426883386
2004	2.341604547
Average	2.480346081

Table 10: Extrapolation for costs of felling.

(a) Region Sweden

Year	$\frac{c_{\text{cutting},t}}{r_t}$
1998	0.389005725
1999	0.372496289
2000	0.400961809
2001	0.400398792
2002	0.423403647
2003	0.403918352
2004	0.393241806
Average	0.397632346

(b) Region South

Year	$\frac{c_{\text{cutting},t}}{r_t}$
1998	0.3043329678
1999	0,3034684749
2000	0,4179798122
2001	0,4148696846
2002	0,4401192815
2003	0,4067635026
2004	0,4056627679
Average	0.3847423559

(c) Region Middle

Year	$\frac{c_{\text{cutting},t}}{r_t}$
1998	0.3223446413
1999	0.3235543901
2000	0.4369904324
2001	0.4479524484
2002	0.4671834575
2003	0.4361978683
2004	0.4367382813
Average	0.1434610144

(d) Region North

Year	$\frac{c_{\text{cutting},t}}{r_t}$
1998	0.3892633092
1999	0.3897293977
2000	0.417374934
2001	0.4087321804
2002	0.4280104522
2003	0.4329348733
2004	0.414077523
Average	0.4114460957

Table 11: Extrapolation for costs of forest management.

(a) Region Sweden

Year	$\frac{c_{\text{forest management},t}}{r_t}$
2000	0.1204427711
2001	0.1206755404
2002	0.1346437050
2003	0.1349851434
2004	0.1449420481
Average	0.1311378416

(b) Region South

Year	$\frac{c_{\text{forest management},t}}{r_t}$
2000	0.1286513242
2001	0.1221165437
2002	0.1375891435
2003	0.1365607994
2004	0.1471807538
Average	0.1344197129

(c) Region Middle

Year	$\frac{c_{\text{forest management},t}}{r_t}$
2000	0.1345026629
2001	0.1318544275
2002	0.1460498882
2003	0.1464426611
2004	0.1584554324
Average	0.1434610144

(d) Region North

Year	$\frac{c_{\text{forest management},t}}{r_t}$
2000	0.1325192248
2001	0.1395526864
2002	0.1552658487
2003	0.1608424485
2004	0.1726120867
Average	0.1521584590

Table 12: Extrapolation for costs of road maintenance.

(a) Region Sweden

Year	$\frac{c_{\text{road maintenance},t}}{r_t}$
2000	0.04265551163
2001	0.04685517786
2002	0.06174636516
2003	0.04676949344
2004	0.04139387429
Average	0.04788408448

(b) Region South

Year	$\frac{c_{\text{road maintenance},t}}{r_t}$
2000	0.04138413982
2001	0.04474084833
2002	0.05982203826
2003	0.04474398529
2004	0.03938473475
Average	0.04601514929

(c) Region Middle

Year	$\frac{c_{\text{road maintenance},t}}{r_t}$
2000	0.04326637944
2001	0.04830859738
2002	0.06350066413
2003	0.04798176551
2004	0.04240177489
Average	0.04909183627

(d) Region North

Year	$\frac{c_{\text{road maintenance},t}}{r_t}$
2000	0.0468960600
2001	0.0505174605
2002	0.06584776187
2003	0.05176395224
2004	0.04652556438
Average	0.0523101598