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Institutional effect on valuation

A study of the storm Gudrun's effect on forest real estate prices

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In January 2005 southern Sweden along with Great Britain, Ireland and Denmark was hit by the storm Gudrun. Our study investigates the storm's effect on forest real estate prices and the effect of counter acting measures taken by institutions after the storm. In order to do this we have studied 63 private forest real estate transactions in Jönköping County during 2003-2006. Applying a hedonic regression model to capture the yearly price changes we find that in our sample there was a large price increase in 2006 and that the results for 2005 are in line with the expectation that the storm made large economic damage. A fully damaged forest would reduce the transaction value with roughly a third, the results are however insignificant given our sample size. In 2005 there was a large price increase in other parts of the country unaffected by the storm. For 2006 we see evidence that the clear price effect can be explained by a positive institutional effect, together with a convergence of price with unaffected areas.

Keywords: Gudrun, Institutions, Catastrophe, Forest real estate, Insurance, Asset price
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Introduction

When a catastrophe hits us, be it illness, loss of employment or natural disaster, we have institutions there to dampen the fall. The security that they provide is one of the cornerstones for a society to flourish. Some of the institutions are governmental and some are private, but their purpose remains the same, to lower risk and uncertainty for the individual, by the means gathered by the collective.

In the winter of 2005, southern Sweden along with Great Britain, Ireland and Denmark was hit by a catastrophe. The hurricane Gudrun (*eng. Erwin*) rolled over with wind speeds up to 43 m/s causing human suffering and severe material damage to Sweden's power grid, railway and forest industry. At the time the Swedish Forest Agency estimated that 75 million cubic meter forest with values of SEK 18 billion was damaged by Gudrun just for the forest industry alone (Swedish forest agency, 2011a). Revised numbers from 2006 are in the region of SEK 11-12 billion (Swedish Forest Agency, 2006).

Luckily, we have functional institutions in Sweden, both governmental and private. One month after the hurricane, the Swedish government declared relief measures to the forest owners such as a general tax cut, diesel tax cuts for forest machinery, funding to salvage storm felling, railway transport fee reduction etc. The ones hardest hit by the hurricane would receive a tax cut of SEK 50 per cubic meter of storm felled forest, corresponding to an operational income of SEK 71 per scmub (solid cubic meter under bark, sv. m3fub). Combined measures totalling approximately SEK 2 billion was put into motion by the government and approved by the European commission during 2005. (European commission, 2005)

The private institutions, represented by the Insurance Federation of Sweden, which members cover more than 90 per cent of the insurance market, made even larger elevated payments of approximately SEK 3.5 billion for 2005 (Insurance Federation of Sweden). 40 per cent of the affected land owners had insurance against storm felling (Swedish forest agency, 2006).

Together these two institutions (public+ private) provided a liquidity boost of approximately SEK 5.5 billion to an industry that faced an expected SEK 18 billion loss of assets while trying to cope with the supply shock created by the fact that almost one year's supply of roundwood was salvaged and sold during the year.

How did this extreme situation affect the way individual buyers perceived risk in forest estates? Can we isolate the effect made by the institutions? How large was the damage made to the forest owners?

Objective

After the storm Gudrun had hit Sweden we expect two different effects. The first being the effect of price differences due to a large increase in roundwood supply that led to lower prices and thus also a decrease in forest real estate prices. The second effect is that of institutions counter acting to minimise the price effect. Since we can observe the total effect on prices for sold forest land and since we can control for the changes in input prices that affects the value of a forest we should be able to isolate the second effect made by institutions. Thus, the objective is as follows:

(1) To isolate the effect that institutions had on real estate prices in the area hit hardest by the storm Gudrun.

Background

Gudrun was by far the most severe storm to affect the Swedish forest industry during the last century (Table 1). Furthermore, some research indicate that the world is getting warmer and the storms will get stronger and more frequent in the future (American Geophysical Union, 2011). Meanwhile our collective resources will get strained by increasing welfare costs due to an aging population. To evaluate and to increase efficiency of institutions will be essential in the future. We hope that this thesis can provide a first step and serve as inspiration to future research within this field. There have also been some speculations in the industry about if Gudrun actually raised prices for forest real estate due to increased equity from the insurance payments, speculations which we hope to straighten out.

Table 1

Storms in Sweden

Date	Worst affected area	Storm felled forest (m3)
1 March 1943	South	5 million
3 Jan 1954	Mid	18 million
17-18 Oct 1967	South	10 million
22 Sept 1969	South	25 million
1 Nov 1969	Mid	10 million
17 Nov 1995	South	5 million
8-9 Jan 2005	South	75 million

Source 1: Forest industries

Previous research

The most obvious starting point is that storms should affect value negatively. Value and money are lost in the storm for the industry, risk perception might go up and storm damaged trees can affect future harvest. However when we have institutions dampening the fall it is not completely clear what should happen.

Effect made by insurance institutions

Individuals are in general risk adverse meaning that they are willing to pay more than the expected future loss to minimise their risk. The insurer can therefore charge a premium above the expected loss in order to handle the risk (Cummins, 2006). The expected loss is the result of the expected severity and the frequency (probability) for the risk to take place. Both variables differ due to type of risk and geographic location. The risk of getting injured by falling icicles is much higher in Stockholm than they are in Söderköping, a small community in Östgötland - mostly two-storey buildings.

Since the fees charged by the insurance companies are under pressure due to a competitive environment, managers will have an incentive to underestimate the risk of catastrophes with very low probability (Cummins, 2006). The expected loss of catastrophes is also often underestimated since the effect of natural catastrophes tends to be fat-tailed, meaning that the loss effect increases exponentially for future catastrophes. Natural disasters are special since they combine geographical concentration with high severity (Kousky, 2010). As an example, the United States Government Accountability Office (USGAO) claims that the combined gathered fee for earthquakes by the insurance industry, in California, for the prior 25-years period amounted only to $3.4 billion while the payment for earthquake Northridge alone amounted to near $15 billion (USGAO, 2007). Furthermore, in 2005 when the hurricane Katrina struck New Orleans, it became the most expensive natural disaster to date in the US. The insured losses were more than $40 billion and the total losses are estimated to exceed $100 billion (Grace and Klein, 2009).

Due to the continuous underestimation of economic damage from catastrophes, insurance fees are shown to go up directly after a major disaster. However, when studying the hurricane Andrew in Florida it was found that the authorities opposed any increases in fees and insurers were only allowed to gradually raise their prices over a period of ten years. (Grace and Klein, 2009)

Gudrun was an above average storm, on Swiss Re's top 40 most severe natural catastrophes, measured by insurance loss, during the period 1970-2005 Gudrun made it in to the fortieth position (Swiss Re, 2006). Should the same effect as in previous research (Cummins, 2006) occur after the storm Gudrun, the affected forest owners should, on an aggregated level, have received more than the fee paid prior to the storm.

In a study made on the federal crop insurance program in the US, authors Goodwin and Rejesus (2008) find that when looking at commercial crop farms in the US over the time period 2002 – 2005, returns were higher for the farms that were insured compared to the un-insured farms. More specifically they find that farms in counties that have a high participation in the previous time period are more likely to join the insurance program. Furthermore, farms in counties that have received higher total government pay-outs are more likely to buy insurance as opposed to the farms in counties that have received high disaster payment. Goodwin and Rejesus (2008) also finds that farmers that receive disaster payments and farmers that have crop insurance have significantly higher returns compared with farms in counties with just government payments. The authors conclude that "*This may suggest that farmers that insure and are in areas with greater disaster assistance are better farm managers. Alternatively, this may suggest that crop insurance and disaster relief payments represent wealth transfers that tend to increase farm income*". (Goodwin and Rejesus, 2008)

Effects of storm damage

Eriksson and Karlsson have in a study simulated a storm level of thinning and studied the effect on total volume. They concluded that, for the observation period of 20-year, a thinning of 70%, measured by ground space, did only affect volume negatively by 15% for spruce and a thinning of 63% affected pine volume negatively with 20% compared to the effect of a weak thinning. They also concluded that the effect became smaller by time. (Eriksson and Karlsson, 1997)

There are of course other types of damages that could impact a sector negatively in a storm, compared to this study, such as semi damaged trees and the fact that the thinning selection of trees is not done in an optimal way. However we can conclude that the large negative effect of a storm should therefore not be in the future values but rather on the direct difference in prices, for saw timber and pulpwood, between and after the storm. (Swedish forest agency, 2006)

Excess liquidity

When there is excess liquidity in a market, asset prices should increase, this because of the higher demand that comes as an effect of the change in liquidity in relation to assets. (Adalid and Detken, 2007)

Insurance payments and cash flow after Gudrun

The insurance companies were the first institutions to counter act the negative effect of the storm. An insurance payment was usually carried out one month after the insurance claim; if the payment was delayed interest was paid. An insurance claim occurs when the wood is picked up, and the loss compared to a normal year is realized. The payments after Gudrun followed the processing of the storm felled wood and were finished during 2006. (Wahlqvist, 2011)

At the time the standard term of the storm insurance policy stipulated that, if half of the standing volume within 1 hectare of land is damaged or if 0.5-1 hectare land, added up to a maximum of 5 hectare, the insurance would cover directly increased harvesting costs, volume loss due to non-optimal adaptation, downgrading from saw timber to pulpwood and, the surplus value of the forest (due to felling that occurred too early). The terms have been changed afterwards to cover not the surplus value but the reforestation cost. (Wahlqvist, 2011)

An estimation given by the forest officer, Gerry Wahlqvist, which we talked to at Länsförsäkringar, the compensation for a damaged hectare would be approx. 60-70 SEK/scmub for the direct cost and approx. 10-20 SEK/scmub for the surplus value, which totals at around 80 SEK/scmub. This differ with the level of storm damage and the growth of the site, since this effects surplus values.

According to Wahlqvist the state subsidies was constructed in such way that there would not occur any overlap between the compensation from the insurance companies and the state. The only overlapping that occurred afterwards was for the allowance of reforestation, since this was added after the storm. The government had at that time already initiated a reforestation support that would pay out a maximum 3,000 SEK/hectare for a spruce forest (Swedish forest agency, 2011c). This would translate to around 5-10 SEK/scmub (own calculations). The largest part of the state subsidies was however the tax relief of 50 SEK/scmub. It was constructed so that the wood must have been salvaged during the period 8 January 2005 to 31 December 2006 and that the volume exceeded one year wood-growth (*sv. tillväxt*) and amount to at least 200 cubic meters. (Swedish forest agency, 2006)

The gross effect should total, using a 30% tax rate, of approx. 78 SEK/scmub (own calculations). The number used in the Swedish forest agency rapport is 77 SEK/scmub using a tax rate of 35% and excluding the reforestation subsidy (Swedish forest agency, 2006).

The forest agency estimated that on average a damaged forest would cost the owner an extra 153 SEK/scmub excluding subsidies and insurance (Swedish forest agency, 2006). If we calculate the net effect, this adds up to negative 75 SEK/scmub with no insurance and plus 5 SEK/scmub with insurance. And it should be said that the total Gudrun cost estimations number SEK 11-12 billion is to a large extent based on this 153 SEK/scmub number (SEK 10 billion). (Swedish forest agency, 2006)

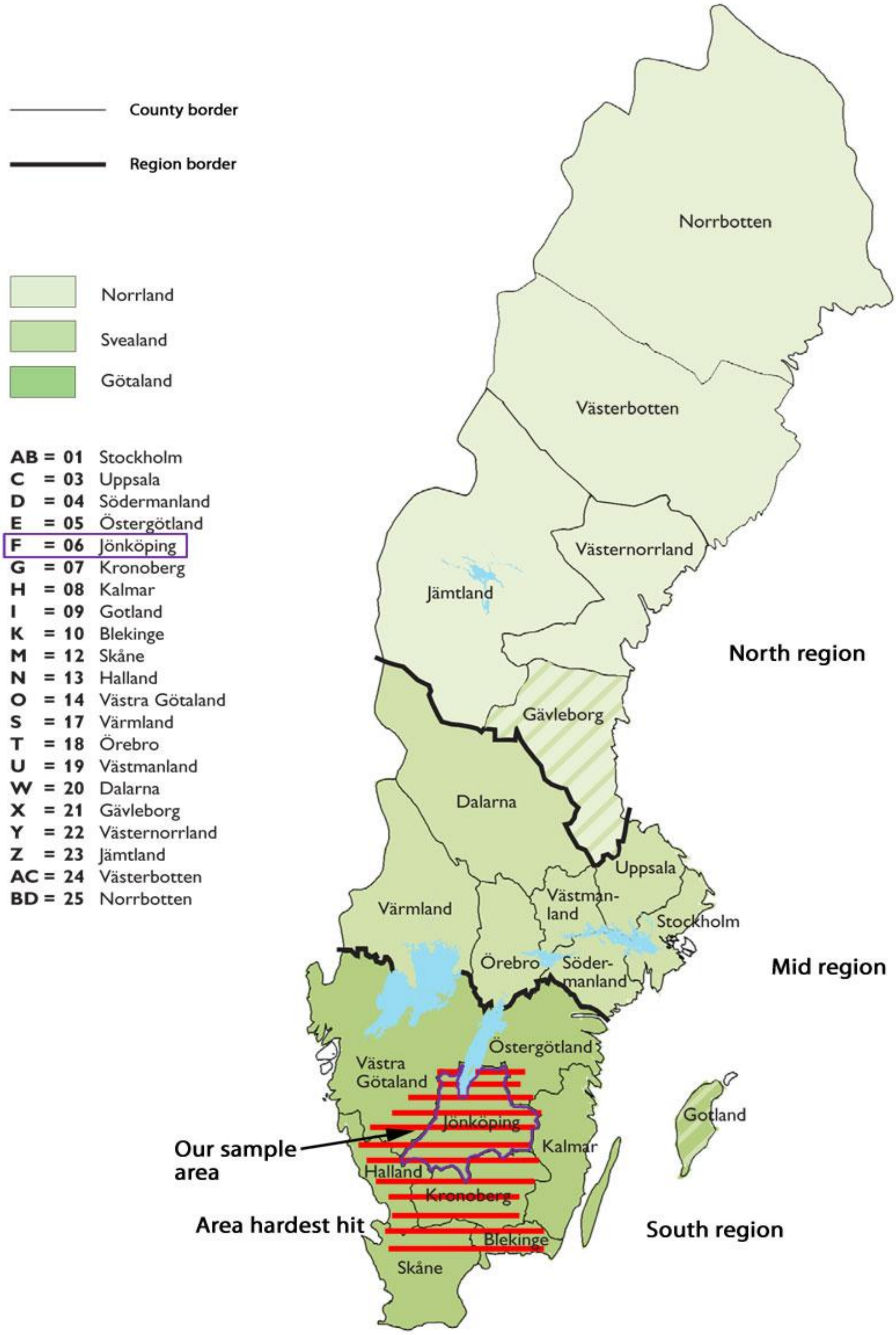
Having storm damaged sectors should therefore affect transaction with no insurance negatively and have no or small effect on transaction with insurance payments following the transaction. It was according to Wahlstrom common that the outstanding insurance payments for storm damaged forest followed in the transaction (Wahlqvist, 2011).

We would also like to point out that the actual payments from both the state and the forest industry (for the sold wood) were not done until the summer of 2006. However we argue that the increase in liquidity already occurs when there is certainty about the amount which you will receive rather than the actual payment. This picture has also been confirmed by LRF-Konsult. (Karlsson, 2011b).

Hypothesis

The total forest asset value for our effect area will become lower due to the storm but will increase asset value per standing timber. Institutions will counter act to compensate the total asset decrease. If institutions would compensate perfectly they would compensate with the exact amount of asset value lost in the storm. The land owner will then try to reinvest their equity in forest assets. But since the value of a newly reforested land is lower than land with older forest they cannot reinvest the whole sum in reforestation. They will use a part of the equity to reinvest in a newly acquired piece of land. This will lead to an increase in demand, and with fixed supply this will increase asset prices and effect valuation.

In numbers, set the forest value pre Gudrun to 100. Gudrun hits and destroys 10 in forest value. The value standing is now 90. Institutions will counteract the storm and give 10 to the land owners. The land owners reinvest 5 in reforestation; since the cost of reforestation is lower than the value of standing timber they cannot reforest 10 on existing land so they will reinvest the remaining 5 in standing timber which will increase demand for the remaining 90.



Source: Swedish Forest Agency and National Land Survey

Introduction to forestry

Before we continue we would like to give you, the reader, the opportunity to gain some basic knowledge about forestry in order to easier understand this thesis. You can always go back to this section when you read the thesis. Should you already be familiar with forestry, or work in the industry, we recommend that you skip this part and go straight to the data description.

We will start by giving a short introduction to forestry practices in Sweden, how the land is cultivated, a short description of forest plans, the "balance sheets" of the forest, and finally an introduction to the industry and the usage of forest resources.

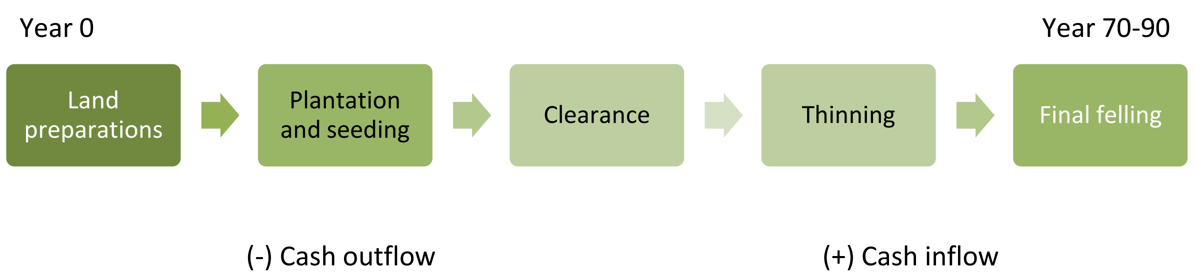
Forestry practices in Sweden

Forestry is characterized by the length of the growth harvest cycle. It is seldom that a human harvests the same forest that he once planted. Rather the land owner plants for the next generation since a harvest cycle is typically between 70 to 90 years for pine and spruce. In economic sense this means that there are large outflows of cash in the beginning of the cycle and large inflows in the end of the cycle.

There are essentially three ways to cultivate a forest: *Trakthyggesbruk, luckblädning* and *stamvis blädning.* The most common in use is *trakthyggesbruk* and its basic steps in chronological order are: land preparation, plantation and seeding, clearance, thinning, sector final felling. For more detailed description about forestry practices please consult appendix 2.

Figure 1

Illustration of cash flows in forestry



Source: Enström, J. mfl. (2005)

Site index (SI)

The site index (hereafter SI) is defined as the potential upper height for a sector by a certain reference age, age 100 for pine and spruce. The SI is designed to be an indicator of growth (*sv. bonitet*) for a sector. **It is important to point out that growth refers to the ground and not the trees, which means that the growth does not change with age of the tree**. The SI is ordered in a class system called SHS (Skogshögskolans system), where you give each sector a number and a dominating tree class. Since the system is in Swedish, G stands for Spruce, T for Pine, B for Birch, L for leaf, this means that G28 is spruce with expected height of 28 meters. This classification is often done by a forest officer and is determined in mature forest by the thickness of the tree and their age, in young sectors the so called intercept, the combined length of five year old sprouts above 2.5 meters in height, and for other sectors the ground conditions depending on brightness of position, texture of humus etc. (Albrektson A., Elfving B. et al, 2008)

Lowest allowed harvesting age

In order for the government to be assured that the strategic resource wood is managed in a desired way, some parts of forestry are regulated by the Forestry Act (1979:429). This includes rules such as how many new plants per hectare that must planted during reforestation, when the land owner is allowed to do clearance, thinning and final felling, how much pine he is allowed to have in a birch dominated sector etc. One of the most important factors is the lowest allowed final felling age. For pine and spruce dominated sectors (above 50%) this is dependent upon the site index and county (Table 2).

Table 2

Lowest harvest age for pine and spruce, Jönköping County

Spruce, SI	G36	G32	G28	G24	G20	G16	G12
Pine, SI			T28	T24	T20	T16	T12
Age	45	50	60	65	70	80	90

Source: National Land Survey of Sweden 2005

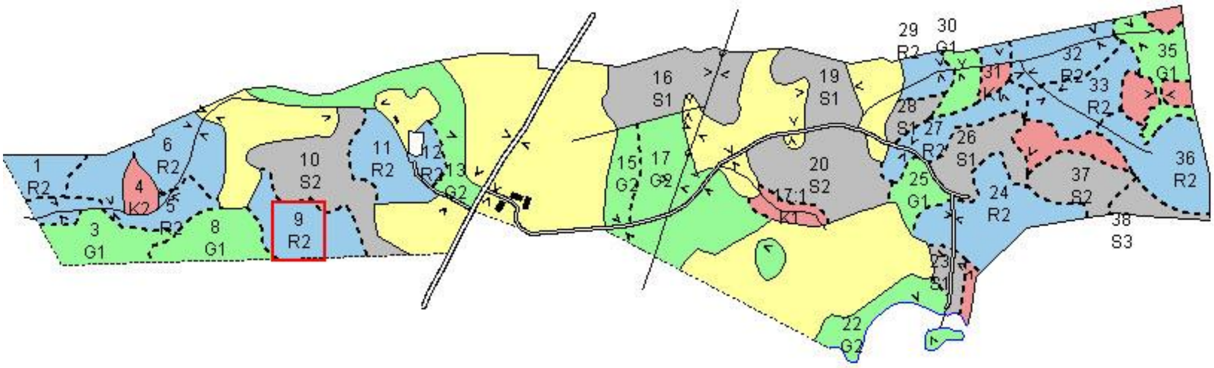
For birch the lowest allowed age is 35 years independent of index and county.

Forest plans

To keep track of the development of the forest assets the land owner are by law obligated to have a forest plan. In an economic sense the forest plan is close to the asset side of a balance sheet. In practice it is a detailed map the land and what type of forest that grows on it (Figure 2).

Figure 2

Forest map

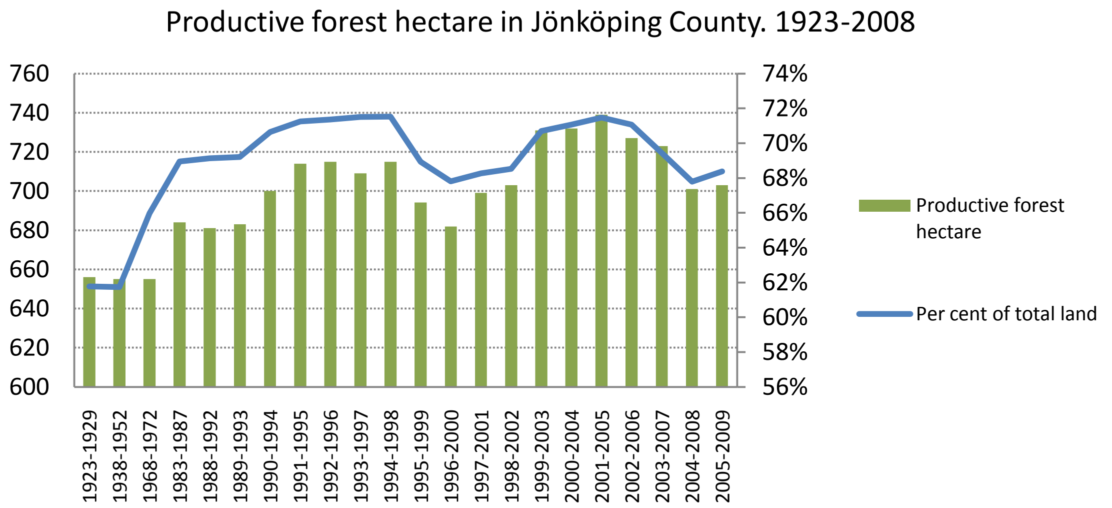


The maps contain codes and sector numbers to keep track of the development. In appendix 3 you will find their detailed meaning. As an example we have highlighted sector 9 with the code R2. This means that this sector contains a Juvenal forest with tree height above 1.3 meters and diameter below 10 centimetres. Using the number 9 we can look up further details in our data and see that this sector has: area 1.4 hectare, age 8 years, contains 15 cubic metre of forest per hectare and that the birch trees in this sector is expected to reach 28 meters in height at year 100. The color codes are simply to keep track of the codes, blue for clearance, green for thinning etc. Yellow is land that is not productive forest land. Furthermore, each forest plan contains other information such as; type of land in sectors, expected growth rates, mixture of tree type, recommended actions needed to be taken.

Conversion of land

At the end of the 19th century there were significantly more open fields than today. During the 20th century the trend has been increasing forestation, when less and less land was needed to supply the population with food it was converted to forest land. Figure 3 shows both the trend of productive forest land as per cent of total land in Jönköping County and the total amount of hectare used for productive forest land. It is important to point out that variations in the composition of land in Jönköping are common, and there exists no restriction when it comes to converting your land from field to forest land or vice versa. A trend during the last decade has been that the EU is subsidizing landowners to keep open field as opposed to converting them to forest land. (Karlsson, 2011b) This means that a sudden effect of a storm should not affect the composition of land and thus not affect the value of the land.

Figure 3



Source: Swedish forest agency, 2010

Forest resource usage

To understand what drives how forests are valued today, one must first establish the usage of forest products. To which players can the owner of a forest sell the products? And are there other forms of usage then strictly economical?

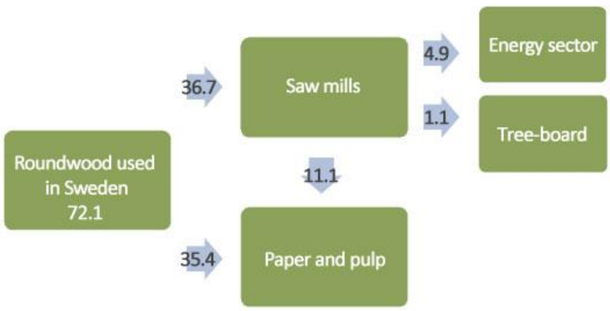
There are two clusters of companies that use forest products, the *forest industry* including paper and pulp, saw mills, and the tree-board factories, and the *energy sector* including electricity, power and heat plants as well as the refined forest fuel factories.

The industries and their use of the forest resources are interrelated. Of the major product from the forest, roundwood, half is used in the saw mills and half is used in the paper and pulp factories. Some roundwood is exported but the vast majority is used in Sweden. There are, however, large regional differences, in the southeast of Sweden only 40 per cent is used for paper and pulp in contrast to the north of Sweden where 65-66 per cent is used in the same industry. In the saw mills half of the input volume is converted to planks, the rest ends up as by-products. The majority part of this spill is used in the paper and pulp factories, the rest is used by the tree-board factories, and the energy sector. (Lundmark and Söderholm, 2004)

Figure 4

Flow scheme over roundwood usage in Sweden year 2009.

(The flow has not changes significantly in the last decade)



Source: Virkesmätningsutveckling, 2010

The factors that determine if roundwood is used in the paper and pulp factories or in saw mills are quality and diameter. The parts of the tree with high quality and large diameter are used in the saw mills, this is defined as saw timber. Smaller parts of the tree and smaller trees are used in the paper and pulp factories, this is defined as pulpwood.

In recent years there has been increasing competition for the forest resources between the forest industry and the energy sector. However Johansson (2001) estimates the price levels that the energy sector is willing to pay for pulpwood to be below the price level that the forest industry is willing to pay. The difference in 2001 was estimated to be SEK 88 per scmub (*sv. m3fub*) with an average price for pulpwood of around SEK 210 per scmub. Even in more recent dates the energy sector sets the price floor for pulpwood (Karlsson, 2010). The competition for pulpwood can continue to change in favour of the forest land owner. (Lundmark and Söderholm, 2004)

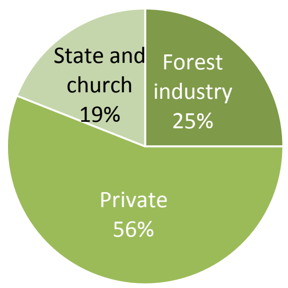
In theory all parts of the tree could be used for either energy or forest industry. All parts that are not saw timber or pulpwood could be used in the energy sector, instead of going to waste. This includes the branches, the crown of the tree and the stub. Historically, the compensation for felling-spill has been 1-2 per cent of total income related to final felling. (Lundmark and Söderholm, 2004)

Ownership of forests

The usage of forest resources is reflected in the ownership of forests. A dominating part of the ownership of forests in Sweden is connected to the forestry industry. The four largest owners are Sveaskog, SCA, Bergsvik skog and Holmen. Approximately 25 per cent of the forests are owned by the forestry industry, 19 per cent by the state and church and the remaining 56 per cent is owned by private individuals. (Swedish Forest Agency, 2010c)

Figure 5

Per cent ownership of Sweden's productive forest land



Source: Swedish Forest Agency, 2010c

The private ownership is concentrated to the southern parts of the country while the industry owns a large part of the forest in the north. The 25 percentage points' difference between the usage of forest resources in favour of paper and pulp in the north, referred to earlier, is a further indicator of this fact.

The increasing competition for forest resources and the different ownership structures has lead to a large difference in value and valuation of forests. We will hereafter go through the different techniques used by the forestry industry and by private individuals. Thereafter we will add some insight to how discount rates can be estimated.

Valuation techniques used

IAS 41 and the forestry industry

The forestry industry has implemented IAS 41 where biological assets should be valued at fair value. The four largest owners have all implemented the IAS 41 and we will use Holmen as an example of how the fair value is estimated. Holmen divides its forests into two parts, land and biological assets (the growing forest). The land part is valued at acquisition cost and the growing forest is valued at fair value. Fair value according to IAS 41 should be established according to the following hierarchy: Level 1: Active market, Level 2: Prices of similar assets, Level 3: Valuation model. Holmen argues that since it owns such a large area, 1 million hectare with 119 million forest cubic meters, there is no active market for its assets. It therefore use a valuation model based on the cash flow effect of its harvest. Here is a brief break down of how the cash-flow model is constructed. (Holmen's annual rapport, 2009)

The Cash flow

The cash flow period is set to 100 years. The level of harvest is determined by a harvesting plan of 2.5 million m3 of timber and pulpwood per year which is set to increase to 3.0 million m3 by 2049. 50 per cent is used as timber, to saw mills, and 50 per cent is used as pulpwood. The selling price is set to the prevailing market price, at the end of calendar year, and is calculated to increase 1 per cent per year until 2035 and thereafter rise 2 per cent per year in line with the assumed level of inflation of 2 per cent. Costs are assumed to rise with inflation.

The discount rate

The rate is set to 5.5 per cent after tax, using the debt/equity target ratio of 0.55, an assumed long-term risk-free rate of 4.5 per cent and a risk-premium of 1 per cent for borrowed capital and 2 per cent for equity. Tax is set to 26.3 per cent.

The value of Holmen's biological assets is estimate to be around SEK 11 billion. The land is set to a value of SEK 100 million.

The value indicates a value/m3 forest to be approximately SEK 90/m3 forest (Own calculations). The average value within the price areas in which Holmen owns forest was, for the first half of 2010, 266-291 SEK/m3 forest (LRF-Konsult, 2010).

Sector-valuation-model (Beståndsmetoden)

This is the dominating model for valuation of non-industry forest real estates in Sweden. The model was developed in a larger study conducted by the *National Land Survey of Sweden* (*sv. Lantmäteriet*) in the late eighties and the result was published in a series of rapports 1988:1-1988:3. The model calculates the potential felling per sector dependent on growth in volume and dimension for the trees and the timing of the felling. This is further dependent on a number of variables such as percentage of leaf trees, damages on the sector, percentage of clearance- and thinning-, growth, stock per hectare, age of sector etc. The felling potential is then converted to cash inflow and outflow and then discounted to a present value. The model is based on a two generation concept of forestry, with the second generation beginning after the final felling made post acquisition. The second generation is assumed to be handled in an optimal way according to the current knowledge level. The most import thing for our part is that it is a cash flow model based on a firm empirical base and is used by forest real estate agents to valuate forest. (National Land Survey of Sweden, 1988:1)

The discount rate:

The model uses two types of discount rates: the regular, fixed discount rate over the whole period of time and the sliding discount rate. The latter is based on the assumption that juvenal- and second generation forests should be discounted with a lower percentage than mature felling ready forests to reflect a more fair value. The discount rate is defined for two points. First, for juvenal- and second generation forests, and the second the point for final felling (end of first rotation period). The rate in between is a linear function of the two points. (National Land Survey of Sweden 2005)

It is a fair question to ask which discount rate should be used since the value of the forest is very sensitive to the compounded rate effect due to uneven cash flows.

LRF-Konsult uses a sliding discount rate of 2.8%-3.2% when valuing forest prospects (Karlsson, 2010).

The sector-valuation-model replaced earlier models called *planmetoden* and *tabellmetoden*. In these models a discount rate of 4 and 5% was used (National Land Survey of Sweden, 1976).

The large difference in prices between the fair value approach that Holmen use and the valuation method applied by LRF-Konsult can in large part be explained by the difference in discount rates. They are very similar as they both use future cash flow to determine the value. We find this to be somewhat puzzling that neither method uses the Gordon's constant growth formula to determine a terminal value, as in company FCF-valuations. For example one could easily assume that the NPV from one generation will become an eternal flow repeated for future generations.

Other approaches in practice

Patrik Lingaardh, responsible for valuating forest investments in *Realfond Skog* gives four general factors which he uses to valuate forest:

1. Price statistics in the area in which the object is being sold, to give indications of value.
2. The real-estate estimated return, calculated from actual return excluding the increase in land value.
3. Your opinion on how land value will continue to evolve.
4. Forest stock, valued compared to other objects relative by tree sort, age and growth

He also points out that one should not get to detailed when valuing forest since he believe that estimation errors are larger than the pricing errors of taking a more holistic approach. When valuing he does not separate between spruce and pine and claims that only large areas of leaf trees will affect the price. He does not compensate for differences in infrastructure since this is already compensated for in the price statistics. However, he does take into account the value of hunting rights, if applicable.

Valuation of non-monetary factors

The forests value of the non-monetary usage can be divided into two categories, one is usage value and one is non-usage value. The first includes recreational purposes, hunting etc. Most of which can in some sense be converted into “cash flow”. Hunting rights can for example be sold and leased instead of utilized by the owner. The second, non-usage value arises because of the existence of it in peoples’ minds, people like the feeling of owning land. Studies suggesting that the pure knowledge that there exist large untouched areas of forests creates welfare to people, even though they never visit the actual place (Kriström, 2000). It has been speculated that there exists a value of purely knowing that you own a piece of land or a forest and that this is somewhat reflected in the price (Lingaardh, 2010).

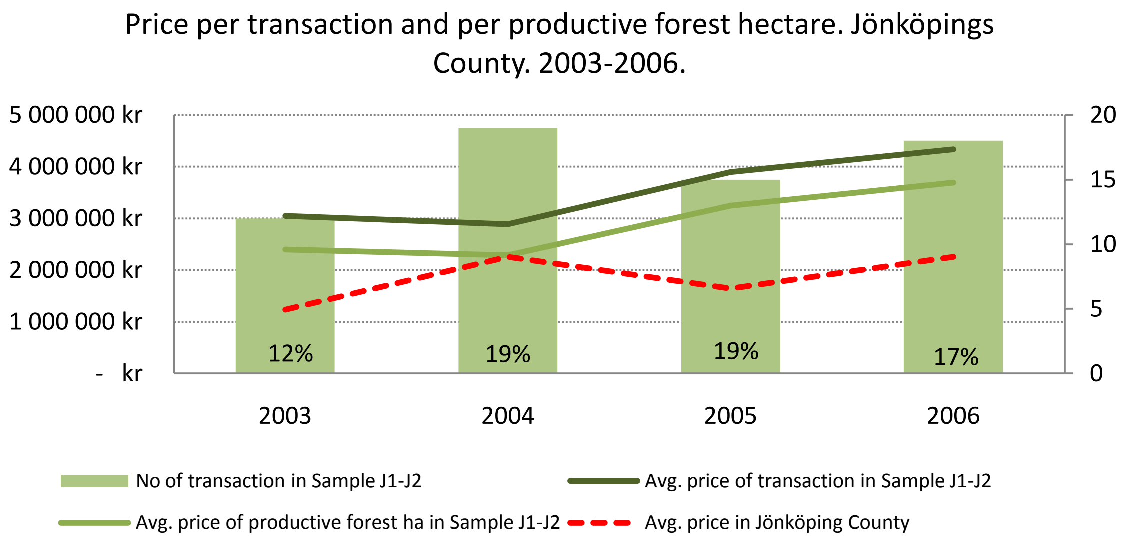
Data description

Transaction data

The main sample of 63 forest plans and corresponding transaction prices has been collected from LRF-Konsult. The sample consists of transactions in Jönköping County (hereafter Sample J). The sample J has been split into before and after Gudrun hit, thus creating Sample J1, J2 (1 for before, 2 for after). Sample J1 consist of 30 transactions and Sample J2, 33 transactions. The total number of forest real estate transactions that took place in Jönköping in 2003-2004 was 198 and in 2005-2006 the number was 184 (Swedish forest agency, 2010a). Our sample covers 16% of the transactions before and 18% of the transactions after.

Transaction prices

Figure 6



Source: LRF-Konsult and Swedish forest agency

Our sample includes forest estates with other assets then biological assets such as buildings, inventories etc. The transaction price and land has been divided, by LRF-Konsult, between productive forest land and other land such as non-productive forest land, farm fields, pasture, lakes etc. An estimated price for the productive forest land alone is given by the data. The estimation is done by the real estate agent who brokered the property. This estimation can of course be exposed to bias since this it is done subjectively. But we believe that this setting allows for a more exact level of discount rates rather than using the whole transaction price. Also, since the transactions have been done by a small number of agents, four agents in total, we can keep track of who did the transaction and check for any bias. (Figure 7)

Figure 7

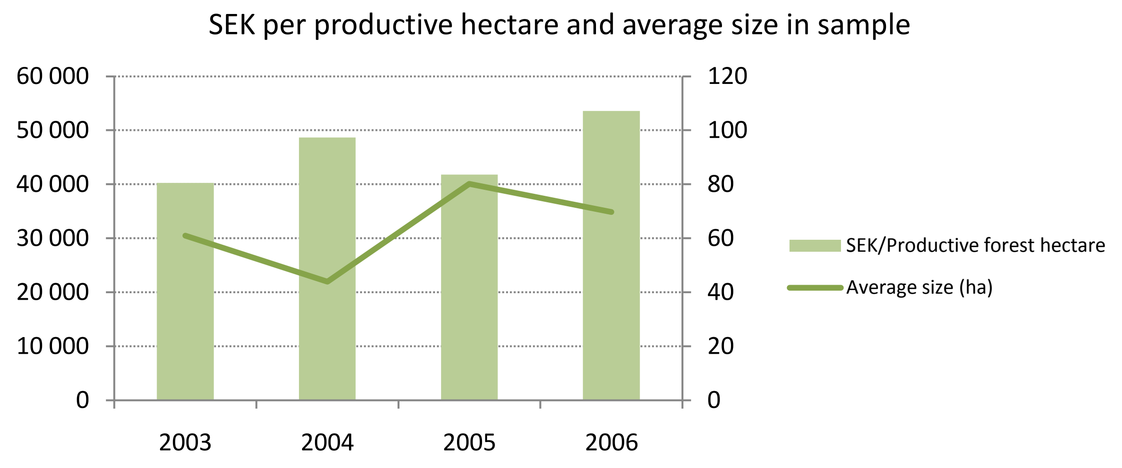
Number of transactions per agent

	Agent A	Agent B	Agent C	Agent D
J1	17	2	5	5
J2	12	12	0	9

Source: LRF-Konsult

We do not have comparable data for productive forest hectare since the Swedish forest agency uses a different technique based on taxation value to estimate the price for productive forest hectare. But as can be seen in the chart (Figure 6) we have a large bias in the price of transaction for forest real estates in our sample compared to the average price in Jönköping County. This can partly be explained by large land size fluctuation between years (Figure 8). When we compare the trend in average transaction price in Jönköping County with the trend for price adjusted to productive forest hectare we see the same zigzag pattern. Thus if the land size for the transaction in the reference sample, Jönköping County, is assumed to have stayed the same between years the bias should be due to size.

Figure 8



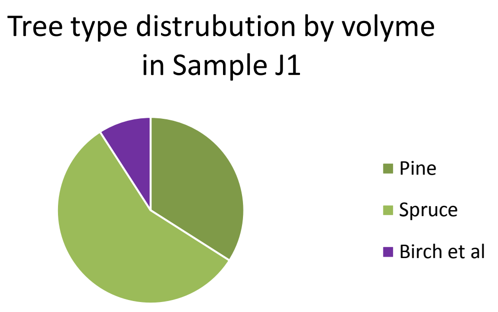
Source: LRF-Konsult

We will therefore include a size coefficient in our regression which will capture the size effect in transaction prices.

Forest plans

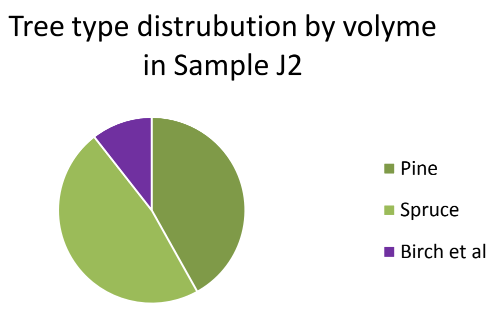
We will now describe the objects in the transactions in more detail. This is done by extracting some of the data in the forest plans that we will be using in the regression.

Figure 9



Source: LRF-Konsult

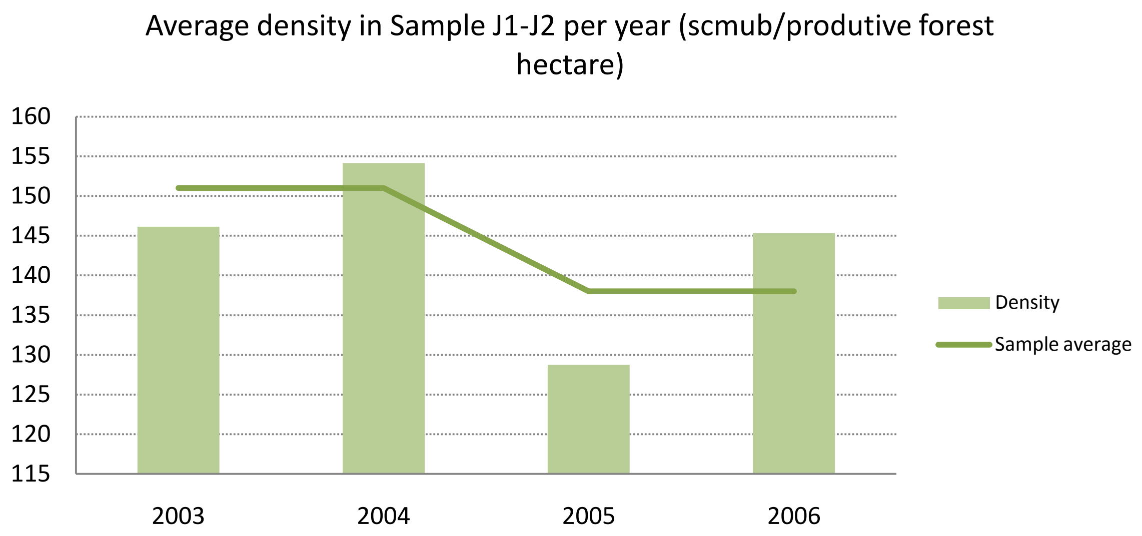
Figure 10



Source: LRF-Konsult

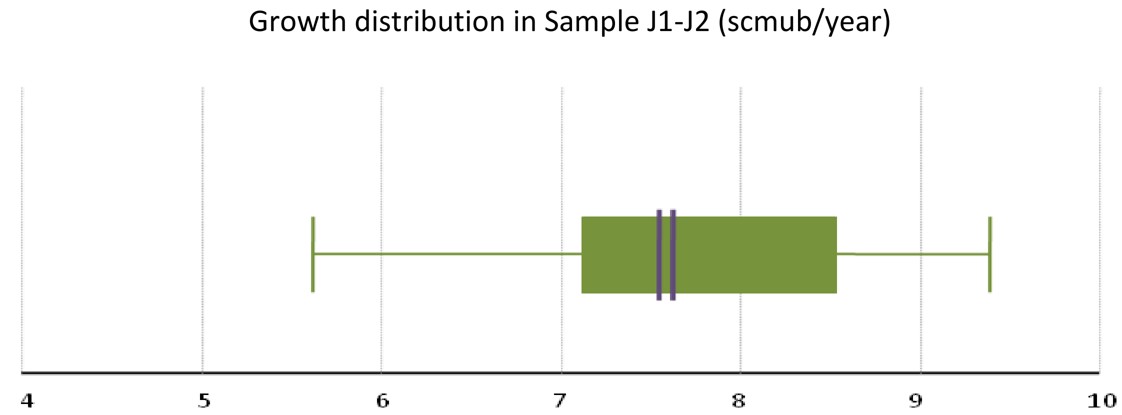
In figure 9-10 we can see a clear difference in volume for spruce between the samples. Since we know that the most common tree felled during Gudrun was spruce, this confirms that sample J2 is coherent with the whole county is this aspect (Swedish forest agency, 2006). We can also see that in our sample the average volume per estate, 7.5 scmub in J1 and 10.0 scmub in J2, has increased but the average volume per hectare has decreased from 151 scmub/ha to 138 scmub/ha indicating a drop in volume of ten per cent (Figure 11). The lower density in sample J2 compared to J1 can partly be explained by a lower average age (Figure 13). However, since the difference in age is not large, it is reasonable to assume that the thinner forests are due to involuntary felling by the storm. This should effect prices negatively and lead to higher discount rates in these areas. We will include tree type distribution, density and age in our regression.

Figure 11



Source: LRF-Konsult

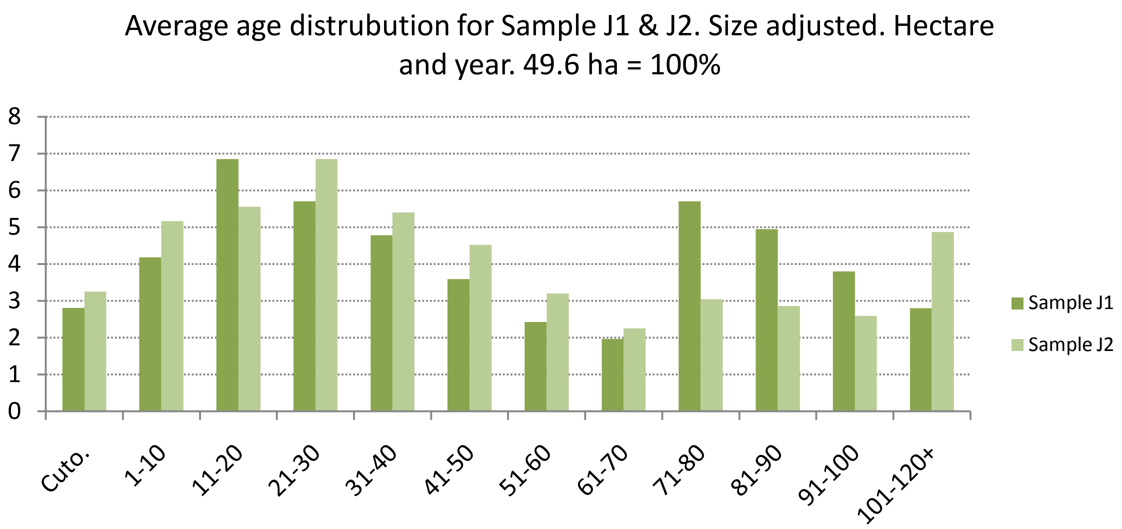
Figure 12



Source: LRF-Konsult

The difference between the samples J1 and J2 are not large. In J1 the average growth is 7.8 solid cubic meters under bark (scmub) per year and in J2 the same figure is 7.6. Figure 13 displays the distribution for both samples combined. Notice that there is a large difference in expected growth within our sample which reflects that many factors determine growth, not just geographic location. If we compare our sample with Jönköping County our sample has an average growth that is slightly below (8.3 scmub/year for the period 2001-2005). (Swedish forest agency, 2010b)

Figure 13



Source: LRF-Konsult

Age is an important factor for volume. In figure 13 we can see that Sample J2 contains significantly less wood in the felling ready classes between 71-100 years and in general more between ages 21-70. The total average age difference is however not large, when calculated we get an average of approximately 49 years for J1 and 47 years for J2.

Storm felled trees

Two-thirds of the total storm felled trees after the storm Gudrun had been collected by the end of September in 2005 (Swedish Forest Agency, 2011b). Our first two transactions during 2005 are in the end of August and have little or no damaged forest. The remaining transactions for 2005 are concentrated around the final quarter. The value of any remaining logs and the ground should be low. It is, however, possible for trees to still be in good condition if they have been connected to the root system (Skogsforsk, 2005). However damages from different forms of fungus and pests should have significantly lowered the value of the trees not connected to the root system. In the event of any existing value left lying on the ground should have captured in the sector tables.

General bias in forest plans

There can be bias in the sample due to the fact that the forest plans are done subjectively by an authorized valuator. There are differences in, estimating homogeneity of sectors, strategies in whatever or not to do a second thinning, estimating volume of forest, and which level of growth to mention a few risk factors (Sjöberg, 2010). Some of the bias in the forest plan we can eliminate by different settings in the models (such as thinning strategies) but some will remain.

Data collection for valuation settings in the sector valuation model

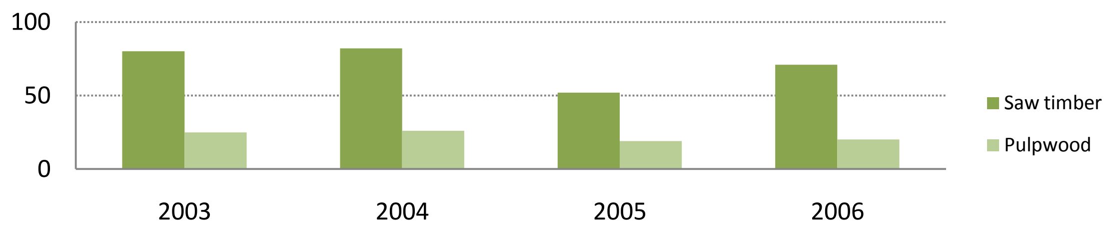
In order to back out a discount rate using the sector valuation model we have gathered additional data that is not stated in the forest plans (see method). These are received price for pulpwood and saw timber, extraction cost and reforestation and cultivation cost.

For received price and extraction cost we use data provided by LRF-Konsult from the relevant period and region. Received price consist of two components, delivery price and premium price (Interview, Sjöberg). Delivery price is reflected in the tables and statistics, which is public information. For premium price, which is not public information, the only data available is for one transaction in 2003. This premium, calculated as a percentage of delivery price, is then used as a proxy for all transactions (Figure 14). It should be noted that the underlying price, delivery price, fluctuates significantly over the years (Figure 15). The delivery price should therefore capture fluctuations in received price over the years.

<u>Keep in mind!</u>
Received price = Delivery price + Premium price

Figure 14

Implied premium prices for saw timber and pulpwood 2003-2006

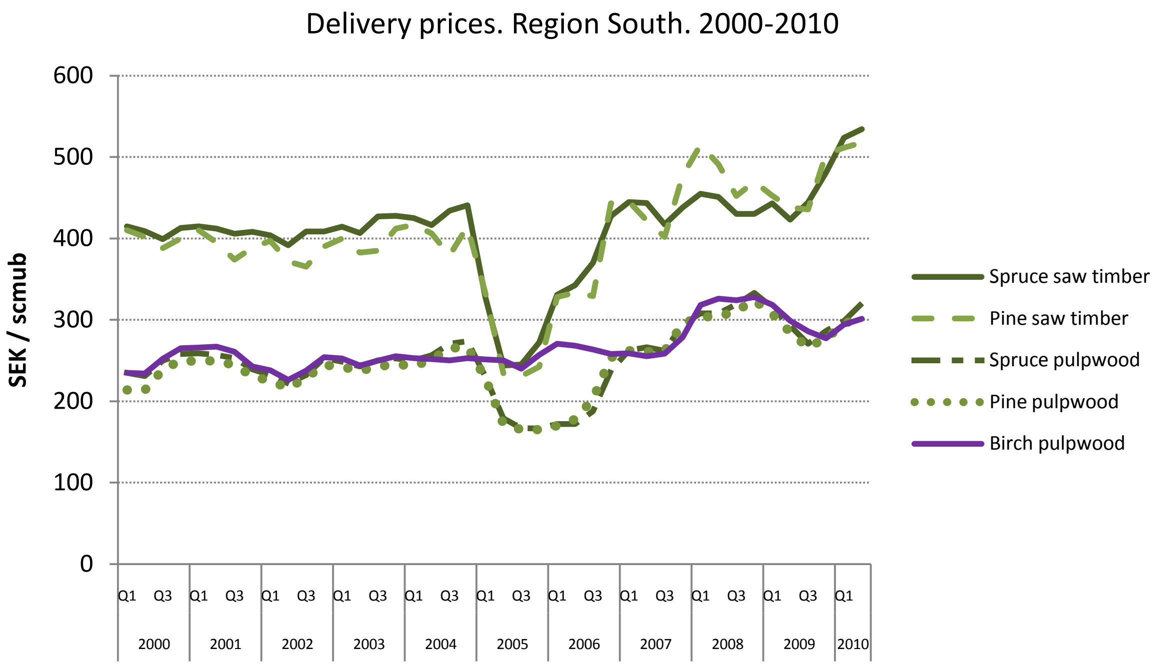


Source: LRF-Konsult

We also gathered delivery prices from the Swedish forest agency in order to make a general comparison of prices between periods. The reason is because the data from LRF-Konsult comes in table form, divided upon diameter class and quality while the data from the Swedish forest agency is an average for all saw timber or pulpwood sold in a quarter per region.

Delivery prices

Figure 15

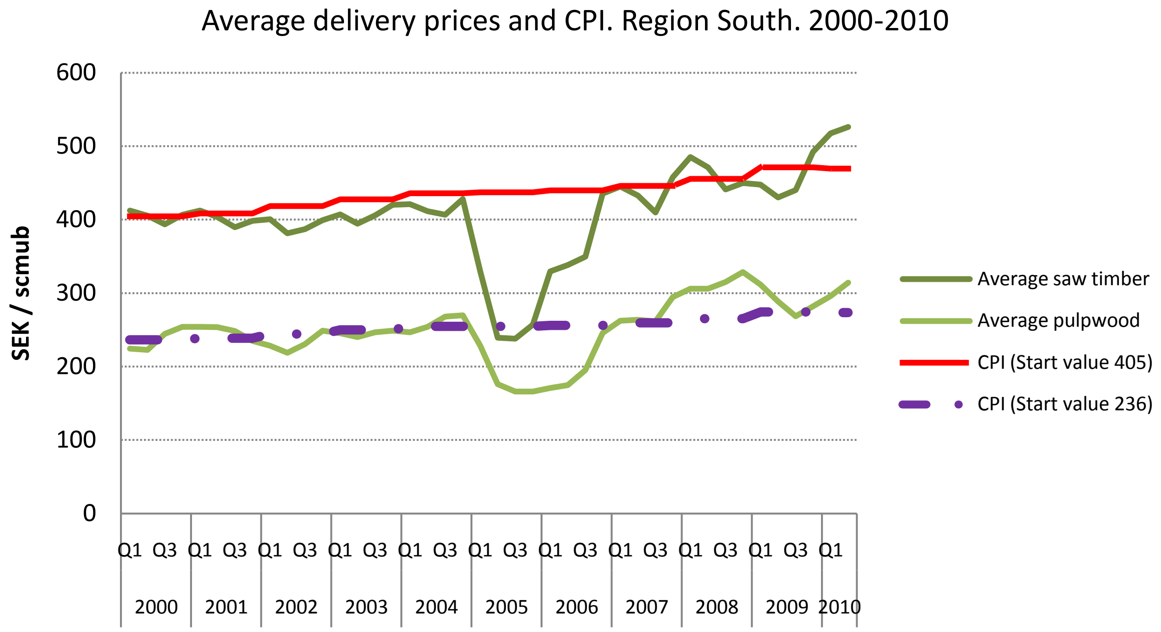


Source: Swedish Forest Agency

We can see a clear drop in delivery prices for both spruce and pine in saw timber as well as pulpwood. Interesting to notice is how birch pulpwood prices did not drop. The reason why birch pulpwood did not drop is because; first the storm felled mostly spruce (Swedish Forest Agency, 2006), second birch is an essential component (non-substitutable) in pulp manufacturing and thus the demand and supply did not change (Karlsson, 2011a). We can also see that the decrease in price is temporary. Two years after the storm hit, prices are back to the same levels as before Gudrun.

During the last ten year period we see a compounded price growth rate of 9.5% increase for spruce saw timber, 14.4% increase for pine saw timber, 19.7% for spruce pulpwood and 23.9% for pine saw timber on yearly average numbers for region south. This would indicate that we have either larger demand or less supply of pulpwood compared to saw timber. And since we know that the supply have remained the same since 2002 (Figure 4) this would confirm that we have seen increasing competition for the pulpwood from, among others, the energy sector.

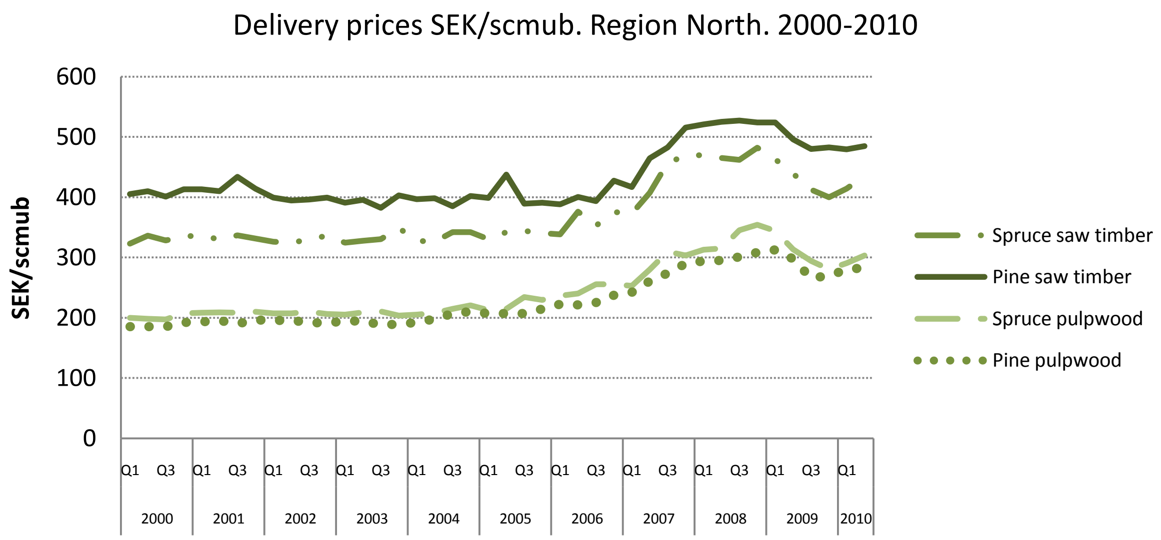
Figure 16



Source: Swedish Forest Agency

If we compare the development of prices to inflation we notice that is not until late 2007 that we start to see prices that are significantly above CPI levels. The average pulpwood price fluctuates less than the average saw timber price. The average price of saw timber was significantly more affected by the Gudrun storm since there are fewer possible buyers for saw timber compared to pulpwood (Figure 16).

Figure 17



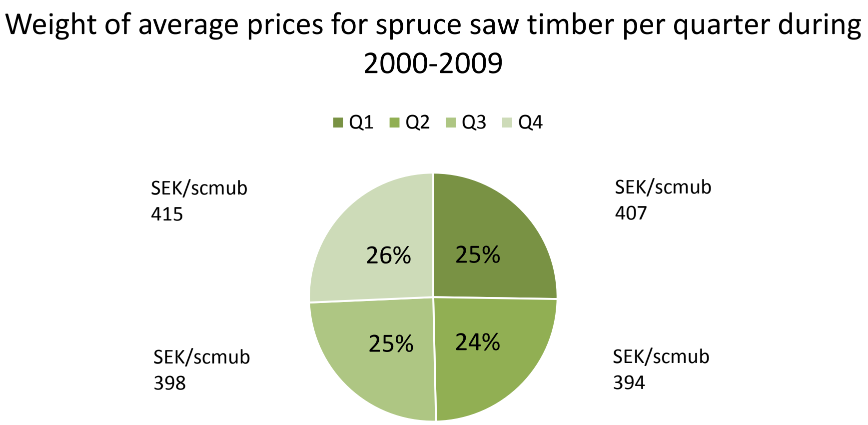
Source: Swedish Forest Agency

We know that the storm did most damage in the south of Sweden which is quite clear when comparing delivery prices between the Northern and the Southern regions. We do not see the same kind of drop in price during 2005. This is among other reasons due to the fact that wood is expensive to transport (Karlsson, 2011a). The factories in the north did not collect wood from the south. What we also see here are that price levels for both saw timber and pulpwood start to increase rapidly during 2007 and are significantly higher still, when comparing 2010 to 2006.

Seasonal prices

There are small fluctuations in delivery prices depending on quarter (Figure 18). We will therefore use yearly average price data in both the calculation of discount rates and in our regression to avoid any bias due to seasonal price changes. Figure 18 serves as an illustration for all the other types of wood, we see the same pattern for both saw timber and pulpwood.

Figure 18



Source: Swedish Forest Agency and own calculations

Additional data

We have gathered additional data on expected future prices, extraction cost for the calculation of the implied discount rate, in the sector valuation model. This detailed data can be found in appendix 4.

Method

The isolate the institutional effect among an array of other effects is not an easy task. There are many variables that should, or can, affect transaction price. We have tried to find all the explanatory variables that make up the value of the forest in order to analyse the difference before and after Gudrun. These variables are then used in order to explain the three dependent variables we are looking at: *effective discount rate, SEK per hectare, and Transaction price (used only in the Hedonic regression)*.

First of all, the input data is accessed through the program PC-Skog, this data is then exported to BM-Win, which is the program used to calculate the value of the forest. Sometimes errors occur in the conversion and sometimes there are errors in the field data. We will on these occasions, if the error is small or affecting only a small sector, use the manual for the program and corrected the error. In the event of a larger error we have dropped the data value. We estimate the bias from this will be small.

The BM-Win program uses the sector valuation method described earlier to calculate the value of the forest. Using detailed information about timber prices, growth, local conditions and the actual transaction price, we have used an iterative process to come up with the *effective discount rate*. The discount rate is calculated using variable prices and costs. The SEK per hectare measure calculated simply using the two input variables transaction price for productive forest land and the area of productive forest land.

We have then used two different methods to see the effects from Gudrun. First of all, we have made an OLS multiple time series linear regression with a dummy variable for Gudrun to see the effects from before and after the storm. Second, Hedonic regressions were made to find the price differences from one year to the next.

We also calculate the standard errors of the residuals to get the part of the price that is not explained by the independent variables. This is done with both effective discount rate and SEK per hectare to check for robustness.

The regressions

The first method is to conduct two OLS multiple time series linear regressions to calculate the coefficients which best reflects the dependent variables *effective discount rate* and *SEK per hectare* (first specification). For sample J1 and J2 where i=1,2,…,n we will use the following equation (Equation 1).

$$R_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \beta_n x_{ni} + g_i + \varepsilon_i \text{ (Eq. 1)}$$

$x_{1,2…,n}$, denotes the variables of the specific forest land, i, that we suspect should have an impact on how the effective discount rate/SEK per hectare are composed, for example percentage of felling mature forest (x_i) in a forest ($_2$) outside Jönköping.

$\beta_{1,2,…n}$, denotes the coefficients of importance that the corresponding (x_i) has to the composition of the effective discount rate/SEK per hectare.

g_j , denotes a dummy variable for the area Jönköping with value 0 before Gudrun and 1 after Gudrun.

ε_i , denotes a random error function.

Hedonic regressions are then performed to see the yearly changes in prices. The model control for the characteristics of the object and then there are a set of dummy variables for the years in the time period as can be seen in the below equation (Equation 2).

$$R_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \beta_n x_{ni} + y_{jt} + \varepsilon_i \text{ (Eq. 2)}$$

Instead of having a dummy variable for Gudrun we use the variable y_j that denotes if property i has been sold in year *t* or not. In the second specification we will use the log of transaction prices instead of using the SEK per hectare, this is done since transactions are of a wide range of sizes and logged variables allows us to see the elasticity of price with the respect to size.

Furthermore, using the Gudrun dummy only tells us about the general price change post Gudrun, not precisely when the effect happens. In order to get a clear view of timing aspect of the Gudrun effect we use a Hedonic time series instead of a before/after dummy. This will allow us to see the price changes year on year, still controlling for characteristics. The Hedonic regression is first of all made controlling only for size and damage then we run another Hedonic regression controlling for all the characteristics of the transactions. Furthermore, a damage dummy that takes the value of 1 if the damage for the transaction is more than 10%. This is to see if results change when only looking at transactions with a large amount of damaged forest. Last, the Hedonic regressions are also done with interacted damage variables to see if independent variables matters more when interacted with the damage variable / damage dummy.

The variables being used for both regressions are as follows:

Fullprice timber pine (fullprice_timber_pine): The received price that foresters receive when they sell their timber on the open market. Since prices for spruce and pine are highly correlated we use the pine price as a proxy for a general timber price.

Storm damage (damage): An area is defined as storm damaged if it is labelled as storm damaged in the forest plan. The storm damaged part of the forest is then calculated as a percentage of the forest area in the transaction.

Agent dummy (agent_x): Three dummy variables that denote of who brokered the transaction.

Pine and spruce of total volume (p_s_of_total): A percentage measure of how much of the standing volume (sv. virkesförråd) that is pine or spruce.

Growth (growth): The growth, productivity, of the land.

Size (size): The size in hectares of the productive forest land.

Average age (average_age): The average area weighted age of the forest.

Density (density): Measures the amount of forest per hectare.

Gudrun (gudrun): A dummy variable that shows if the storm Gudrun has occurred (1) or not (0).

Results

Without taking characteristics into account, the distribution of rates seems to have shifted somewhat toward higher interest rates after Gudrun. The average value of implied discount rates is 0.021 pre Gudrun and 0.024 post Gudrun, SEK per hectare is 46,378 pre Gudrun and 48,621 post Gudrun (Figure 19-20). Gudrun seems to have shifted rates upwards but SEK per hectare is inconclusive. However, remember that this is just descriptive data not taking the characteristics of the transactions into account.

Figure 19

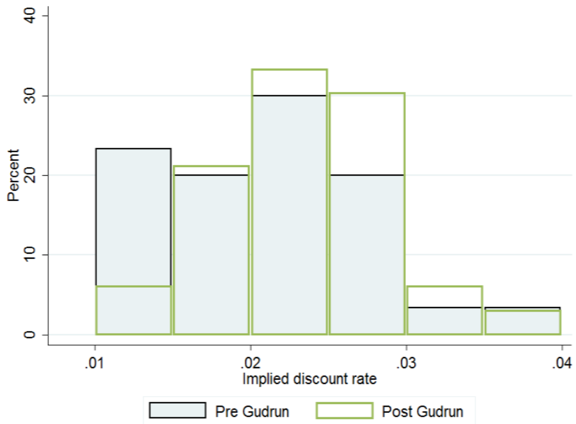
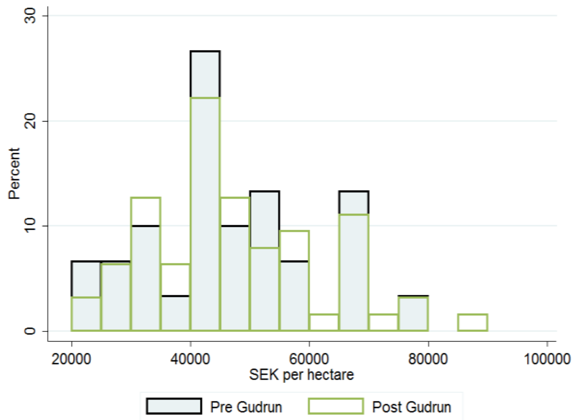


Figure 20



First specification (Gudrun dummy):

Next we have run the regressions on implied discount rates and SEK per hectare. The results can be seen the table below.

Table 4

imp_disc	Coef.
timber price (pine)	-0,00005
	(-3.33)
damage	0,00797
	(1.22)
size	0,00000
	(-0.18)
agent_b	0,00020
	(0.1)
agent_c	0,00159
	(0.65)
agent_d	-0,00181
	(-0.98)
density	-0,00003
	(-2.28)
p_s_of_total	0,01097
	(1.44)
growth	0,00247
	(3.32)
average_age	-0,00007
	(-1.51)
gudrun	-0,00285
	(-1.23)
_cons	0,02544
	(2.36)
R-squared	0,4348

sek_per_ha	Coef.
timber price (pine)	69,940
	(3.21)
damage	-13 831,920
	(-1.48)
size	17,520
	(0.81)
agent_b	3 540,367
	(1.25)
agent_c	974,274
	(0.28)
agent_d	829,090
	(0.31)
density	244,375
	(11.24)
p_s_of_total	-3 352,421
	(-0.31)
growth	2 167,007
	(2.04)
average_age	11,626
	(0.18)
gudrun	13 652,190
	(4.12)
_cons	0,025
	(2.36)
R-squared	0,8074

First, we can conclude that out of all variables we have 95% significance or higher for timber prices, density and for growth. Timber prices and density have negative coefficients for implied discount-rates and positive for SEK per hectare. Growth has a positive coefficient for implied discount rate as well as SEK per hectare. We do not observe any bias between agents or effect from tree type distribution.

For the dependent variable SEK per hectare we see a significant Gudrun effect which raises prices and correspondingly lowers discount rates. We see a large negative economic effect from the damage, roughly a third of implied discount rate and SEK per hectare, however with our small dataset the result is not statistical significant. Furthermore the amount of transactions that have storm damaged forest is small, 38% of our sample. This number is for the whole sample, both before and after Gudrun, the corresponding number for after Gudrun is approximately 73%. This could mean that a small change in the number of transactions with storm damages forest would change the coefficients and significance.

Furthermore, no significant effect from different agents or variations in size can be seen. There are some signs that the mixture of tree type (p_s_of_total) and average age affects the implied discount rates (both for fluctuating and fixed prices), however, this is only at a significance level of 85%, too low to be considered statistically significant.

Second specification:

We have dropped the timber price variable since it gave a clear problem of multicollinearity, timber prices being very correlated with the Gudrun dummy in general and the 2005 year dummy in particular since timber prices in the sample region dropped sharply after the storm. Removing the timber prices should be consistent with the idea that informed and rational investors will see that the supply chock and price drop in timber is likely to be very temporary compared to the average growth cycle of a forest, i.e. if output prices are low now the owner should be able to wait and get the "fair" price in a few years' time for the part of his land that was unaffected by the storm. However, remember that the negative price effect due to the drop in timber prices should now be captured by the other variables.

Table 5

log_price	Coef.	Coef.
damage	-0.3200	-0.3040
	(-0.96)	(-0.89)
log_size	1.0186	1.0183
	(18.8)	(18.63)
i_log_size	-	-0.1226
	-	(-0.24)
year_2004	0.1433	0.1432
	(1.27)	(1.26)
year_2005	0.0122	0.0138
	(0.1)	(0.11)
year_2006	0.2907	0.2874
	(2.42)	(2.36)
_cons	10.5402	10.5414
	(46.78)	(46.39)
R-squared	0.8734	0.8735

Middle column is results from regression without interacted variable(s), right-hand column is with interacted variable(s).

When running the regression without controlling for characteristics we can see that damage has the expected sign but no statistical significance, most likely due to the small number of observations. The logged size variable is very significant and positive, but the interaction between damage and size is not significant. When looking at the years it is clear that no statistically significant conclusions can draw be from year 2005 and 2005 but the 2006 dummy is positive and significant. (Table 5)

The economic significance of the coefficients is also interesting, as can be expected an increase of 1% in the log_size gives a price increase of 1%. The year dummies are inconsistent when it comes to economic significance but notable is that 2005 gives a much smaller increase compared to the base year 2003, i.e. a decrease compared to 2004, in line with what can be expected. Furthermore, the year 2006 gives a very large effect to the price from year 2003 to year 2006 the increase was almost 30%. The damage variable might at first glance appear to be of similar magnitude but the damage variable has a maximum of 1 and a large change would be somewhere in the region of 0.1, interpreted as an increase from e.g. 0% to 10%, such an increase would only give a price decrease of approximately 3%, which is in line with earlier results in the first specification. (Table 5)

We then reconstructed the damage variable as a damage dummy. The dummy is specified as 1 when the damage is above 10% and 0 if the damage is below 10%. This is done in order to differentiate between transactions with little or no damage from the ones with significant damage. We have also added an interaction term to see how the damage effect changes with other variables. i.e. growth could be more important when explaining the price of the land has damaged forest then if it does not. (Table 6)

Table 6

log_price	Coef.	Coef.
damage_dummy	-0.0109	-0.0080
	(-0.1)	(-0.07)
log_size	1.0170	1.0414
	(18.62)	(17.72)
id_log_size	-	-0.1748
	-	(-1.11)
year_2004	0.1429	0.1490
	(1.26)	(1.31)
year_2005	-0.0124	-0.0166
	(-0.1)	(-0.13)
year_2006	0.2565	0.2497
	(2.16)	(2.11)
_cons	10.5463	10.4532
	(46.45)	(43.26)
R-squared	0.8714	0.8741

Middle column is results from regression without interacted variable(s), right-hand column is with interacted variable(s).

When running the same regression with the damage dummy instead of the damage variable, the magnitude and significance changes but the same conclusions can be drawn. The reasoning that could explain the relatively larger effect of the interacted damage dummy and size relative to the normal damage variable interacted could be that size is undesirable when it is conditional on a large portion of the land being damaged. (Table 6)

The economic significance of the regression using the damage dummy shows the same characteristics as the above regression when it comes to log_size and the year dummies. The damage dummy shows that if the damage was major(>10%) or minor (<10%) has almost no impact. However, when integrating the log of size and the damage dummy we can see that major damage does have a larger negative effect on the price than when integrated with just the damage variable (Table 5).

Table 7

log_price	Coef.	Coef.
damage	-0,1880	-0,3259
	(-0.91)	(-0.68)
log_size	1,0301	1,0450
	(34.20)	(26.46)
agent_b	0,0857	0,0588
	(1.34)	(0.69)
agent_c	-0,0062	-0,0091
	(-0.08)	(-0.10)
agent_d	0,0232	0,0269
	(0.38)	(0.36)
density	0,0051	0,0050
	(10.62)	(8.02)
p_s_of_total	-0,0388	-0,1692
	(-0.16)	(-0.39)
growth	0,0438	0,0487
	(1.91)	(1.85)
average_age	0,0005	0,0012
	(0.35)	(0.65)
i_log_size	-	0,3074
	()	(0.57)
i_agent_b	-	-0,4077
	()	(-0.35)
i_agent_c	-	(dropped)
	()	()
i_agent_d	-	0,0527
	()	(0.07)
i_sk_per_ha	-	-0,0032
	()	(-0.31)
i_p_s_of_t~l	-	-1,4236
	()	(-0.32)
i_growth	-	0,1612
	()	(0.53)
i_average_~e	-	0,0098
	()	(0.38)
year_2004	0,0794	0,0843
	(1.23)	(1.16)
year_2005	0,0672	0,0823
	(0.97)	(1.03)
year_2006	0,2366	0,2378
	(3.38)	(3.05)
_cons	9,4281	9,4304
	(29.05)	(21.98)
R-squared	0,9702	0,9709

log_price	Coef.	Coef.
damage_dummy	-0,0116	0,1675
	(-0.17)	(0.92)
log_size	1,0285	1,0415
	(33.93)	(31.23)
agent_b	0,0936	0,0748
	(1.46)	(1.05)
agent_c	-0,0103	-0,0154
	(-0.13)	(-0.18)
agent_d	0,0060	0,0009
	(0.09)	(0.01)
density	0,0051	0,0051
	(10.60)	(10.07)
p_s_of_total	-0,0212	-0,1156
	(-0.09)	(-0.45)
growth	0,0417	0,0371
	(1.81)	(1.43)
average_age	0,0007	0,0005
	(0.49)	(0.35)
id_log_size		-0,0338
	()	(-0.17)
id_agent_b		0,0625
	()	(0.28)
id_agent_c		(dropped)
	()	()
id_agent_d		-0,2167
	()	(-0.85)
id_sk_per_ha		-0,0077
	()	(-1.43)
id_p_s_of_~l		2,5116
	()	(1.75)
id_growth		0,1747
	()	(0.93)
id_average~e		0,0181
	()	(1.14)
year_2004	0,0842	0,0893
	(1.29)	(1.29)
year_2005	0,0603	0,0274
	(0.84)	(0.36)
year_2006	0,2202	0,2447
	(3.20)	(3.29)
_cons	9,4211	9,4979
	(28.79)	(26.63)
R-squared	0,9697	0,9726

Middle column in each table is results from regression without interacted variables; right-hand column is with interacted variables.

When adding the characteristics to both regressions we see that the same conclusions are valid, and statistically significant variables are log_size, sk_per_ha (density) and growth. Since the damage dummy has a very small sample size it can be risky to draw far reaching conclusions is interesting nonetheless to note that p_s_of_total has a high significance (t-stat of 1.75) a large coefficient only when interacted with the damage dummy. (Table 7)

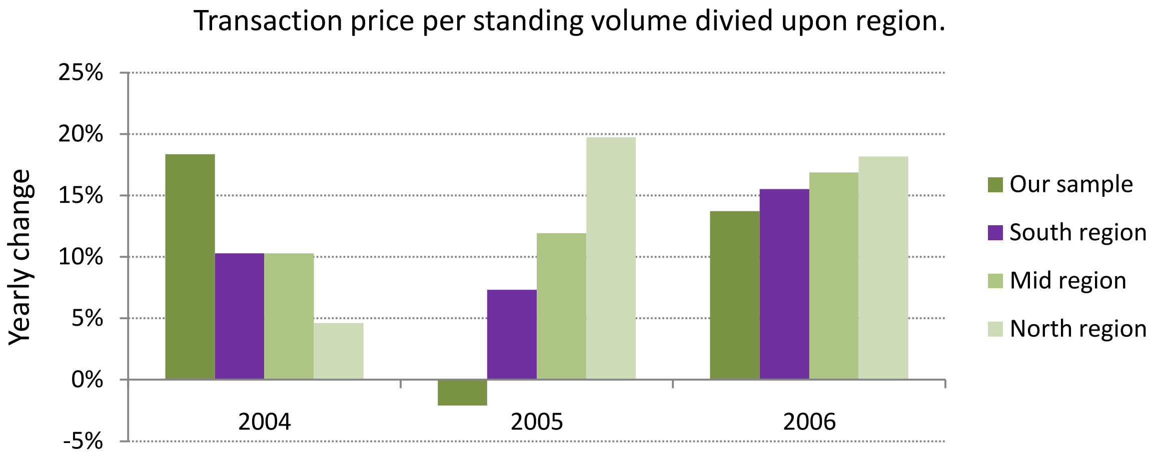
Variables become relatively more important when interacted with the damage_dummy than with the damage variable, when there is only a smaller amount of the forest left the quality of the remaining trees becomes more important.

The density variable is very significant but appears to be insignificant when it comes to economic significance, given the mean of 144 and standard deviation of 47 a change in the density has little effect on the price. Regarding the year dummies the same effect as in the previous regressions can be seen, with 2005 showing a small decrease compared to 2004 but the large increase comes in year 2006 when all specifications of the regression show results over 20%.

Analysis

From our regressions it is clear that prices are higher after the storm Gudrun then they were before, and consequently the implied discount rates are lower. For the specific real estate we can see indication that damage has a large negative effect on price, however not significant with our dataset. When controlling for characteristics of the transactions there could be other things changing over the sample time period, something that the Gudrun dummy and year dummies would capture. If the forest market develops positively driven by increased preferences for forest assets our time dummy variables will capture such an effect as well effects made by the institutions. We see indications that our sample and the South region underperformed compared to the Mid and North region during the two years after Gudrun (Figure 21). When looking at the number of transactions taking place, we see that approximately 0.2% of productive forest land in the South region, and 0.1% in the Mid region were sold in 2006. Furthermore, the general price data is not taking special characteristics of the land into account (own calculations, Swedish forest agency).

Figure 21



Source: LRF-Konsult

When investigating the compensation levels to forest owners from both the government and the insurance companies we find scenarios which could leave the insured forest owners on a higher asset value level then prior to the storm but the majority part of the forest owners should have been affected negatively. However, since the values are only average values it could be that there is a perish with forest owners that all received public and private insurance payments, then the compensation for the area as a whole could be higher after then before which could lead to that an area is overcompensated.

The hypotheses that increased liquidity leads to higher prices could also explain why we see a year effect for 2006. When forested owners have received their compensation and have used a part of the compensation to reforest their land it is not unlikely that they used the remaining money to buy new land. This would give explanation to why the terms of condition was changed to only cover reforestation and not surplus value. The reason why we do not see a year effect for 2005 could then be explained by timing effects; during 2005 it is unlikely that you would have had the opportunity to reforest your land nor had the time to think about reinvesting in new land.

When we analyze the year dummies all are insignificant with the exception of 2006. It is however interesting to note that the year 2004 coefficient is larger and has a higher t-stat than year 2005. Since the dummies should be interpreted as the change compared to year 2003 this can be interpreted as a relatively stronger effect for 2004 and a negative year-on-year effect for 2005. This we interpret as multiple contradicting effects occurring during 2005.

Furthermore, when studying the economic significance we note that size is the by far most important variable when determining the price, along with density. When looking at growth we see that an increase with one standard deviation gives an increase of approximately 4%, not a large increase but in line with the reasoning above that growth is not an important metric when valuing forest. The average age could be expected to drive prices but as with growth the results are small, the age of the forest should be important since the actual cash-flows are closer in time. The insignificance of variables that could be expected to be important can be because the insecurity of the measurements, i.e. the area of a plot is easy to measure but the relative quality (variable such as average_age, growth etc.) is harder and there is room for measurement or estimation errors. It could also be that buyers look at softer factors (hunting or fishing rights, location relative to buyers etc.), factors that are difficult to account for unless making a qualitative study.

When looking outside our sample we can see what appears to be a general price increase, larger than what could reasonably be motivated by the increase in timber prices. This should indicate a general price increase in those regions. We then see two major effects, namely the storm and the change in preferences counteracted each other during 2005, which could explain the insignificant year effect without involving institutions.

If we assume that the increase in forest estate prices in for example the Mid region is due to an increase in preferences for forest land then this increased preference does not show in the results for our sample. However, in 2006 we see yet another price increase in all regions of the country, but this year we also see an effect in our sample even when controlling for characteristics of the transactions. Of course any far reaching conclusions should not be drawn from comparing our regression results with transactions with no controls for characteristics, but given the larger sample size when including all transactions it should be safe to make some conclusions regarding the development of transaction prices in the country.

The sudden effect, i.e. that our sample now shows a development similar to the rest of the country, should then be to the introduction of a new factor or the removal of an old one. If we choose to accept the hypothesis that 2005 asset price effect does not contain any instructional effect then we can partially explain the 2006 asset price effect with an introduction of the institutional effect.

Robustness and suggestions for improvements

In order to test the robustness of the regressions we have run the regressions without characteristics and only year dummies. This was done to control if the damage variable captured all the effect of the storm, something that would affect coefficients and t-stat of the year dummies. However, when removing the damage variable and other characteristics we find only very minor changes. The changes are not of a magnitude to change the results. We have also predicted the residuals for before and after Gudrun. The standard deviation for the residual: implied discount rate is pre Gudrun 0.0046 and post Gudrun 0.0043 SEK per hectare is pre Gudrun 7126 and post Gudrun 5632.

Figure 22

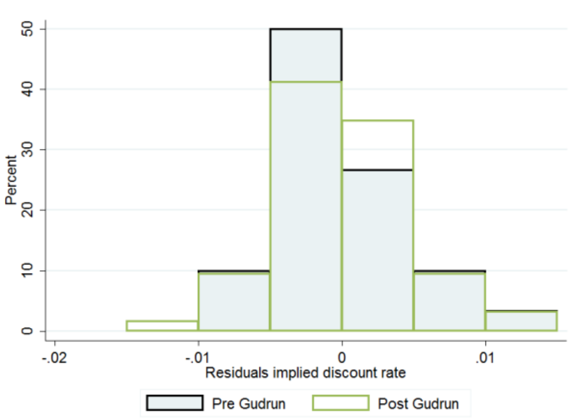
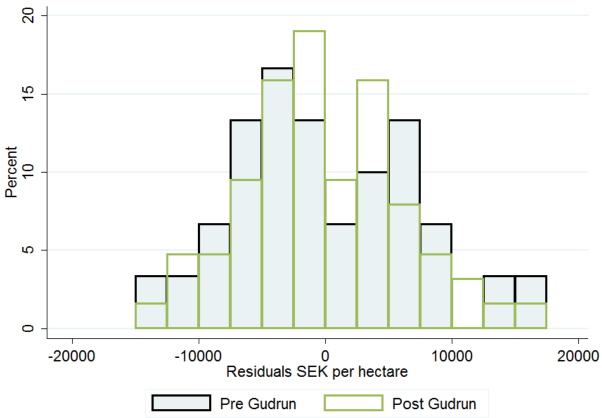


Figure 23



Other remarks

Our period of time series analysis might have been a bit too short to capture and evaluate the whole Gudrun effect. The purpose however was to try to isolate the effect that institutions had after the storm and we think it was reasonable to look at the period two years after the storm. Furthermore, in 2007 another storm, Pär, occurred making it difficult to separate the effects of the different storms when looking at the whole time period

It would have been beneficial to have collected data for a reference sample in an area that was not effect by the storm and not being part of the same market as our sample. This would have helped us compare the effect of our Gudrun dummy with how this unaffected area developed during the same time period.

Future research

For future studies in this subject we suggest the usage of a longer time series after Gudrun since our expected effect could have affected later years as well. Using a longer time series would make it possible to see if the effect of Gudrun decreased with time.

A larger set of data will probably provide more significance to our damage variable. This should be investigated in future research.

Before Gudrun it would have been good to further examine how the affected area in Jönköping correlated with the rest of the region and with other regions.

It would have also been interesting to look at who bought the properties and if this changes after Gudrun. One hypothesis could be that Gudrun attracted more buyers to the market since people thought the storm would lead to lower prices.

To investigate how changes in the financing of forest real estate have changed during this period. If for example the self-financing part of forest transaction increases after the storm.

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Appendix 1

Slutavverking: Final felling
Avverkningsrester: Felling-spill
Rundvirke: Roundwood
Elcertificat: Electric certificate
Risrensning: Felling-spill-clearing
Ungskog: Juvenal forestes
Röjning: Clerance
Gallring: Thinning
Skogsråvaror: Forest resources
Värmeverk: Heat plants
Bränsleförädlingsindustrin: Forest fuel factories
Stammar: Stock
Bonitet: Growth
Lantmäteriverket: National Land Survey of Sweden
Kallhygge: Cutover
Leveranspris: Deal price
Hänsynsmark: Deference land
Virkesförråd: Standing volume
County table: Länstabell
Quality table: Kvalitetstabll

Appendix 2

Land preparations (year 0)

Clearing: At the final felling you remove all the trees that can be used as roundwood in either saw mills or in paper and pulp factories. The remaining small trees and bushes must be cleared as part of land preparation. This is done to lower competition for new plants soon to be put into the ground. The material from the clearing is normally not collected and has low economic value.

Ground preparations: Burning, patch slashing, harrowing, and tilling are the three different approaches. Burning: You set fire to the clearing to release nutrition for the new plants. This is not a very common practice today. Patch slashing and harrowing: You remove the upper layer of the ground in patches or in lines. In the patch, or rather on the small hill created by the harrowing, you plant the tree. Patch slashing is common. Tilling: Used in some parts of northern Sweden. Basically, like tilling on farmland, you till a ditch for irrigation and plant the tree on the terrace created between the ditches.

Plantation: Self seeding, and plantation (year 0-2)

Self seeding: Usually this is done by selecting seed-trees in the area which is about to get harvested. You clear the area around the tree in order to strengthen and prepare it to be able to stand alone. When the final felling is executed you leave the selected trees. This practice is more common in pine dominated sectors, since spruce more seldom have a “good seed year” which leads to spruce being more difficult to self seed. There is also a simpler version of self seeding where you don’t leave any seed-trees left in the sector but rather just leave it to nature. What usually happens then is that you get a mixed forest with birch and pine. If the sector is under shadow spruce will appear. You can then cut down the trees which are not wanted and cultivate a pure sector with time.

Plantation: Seeding and plantation. There is also the option of not leaving it to nature at all. You can now a day choose genetic material which has better growing potential than the local breed. For pine you usually fetch small trees and seeds from north of your location, and Spruce from south of your location. How far you are allowed to move the genetic material is regulated by law.

Seeding is simply to distribute seeds over the grounds after land preparations.

Plantation means that small, one or two year old plants, are planted. This is the quickest way of reforestation. When you plant the trees you plant them very tightly together. This way the trees grow slowly in the beginning of their lives which increases the quality.

Clearance (year 10-30)

The total volume for a forest increase most rapidly if it is left alone, however, this comes at the expense of lower quality. In order to assure the highest value and quality in the forest you usually perform the clearance during the early cultivation period of the forest. The material cut during the clearance can sometimes be used as fire wood but the cost is usually too high for it to be profitable. Low or negative economic value of extraction.

Thinning (year 30-50)

Essentially this is the same as clearance but now the trees are larger and are used as pulpwood giving them economic value. In the northern parts of Sweden two thinnings are sometimes made due to longer harvest cycles.

Final felling (year 70-90)

The result from the final felling is a cutover section. Normally you harvest all the trees except some seed trees to reforest the section. Still only about 60-65 per cent of the trees' biomass is extracted. The remaining part consists mainly of stubs and roots.
There are some variations of final fellings which allow you to extract more from the cutover:

Stub extraction: You extract the stubs from the cutover and use them as pulpwood. (Not very common)

Cutover clearance: You remove the remaining part of the tree, the crown, branches etc. (Not very common)

(Enström, J. et al, 2005)

Appendix 3

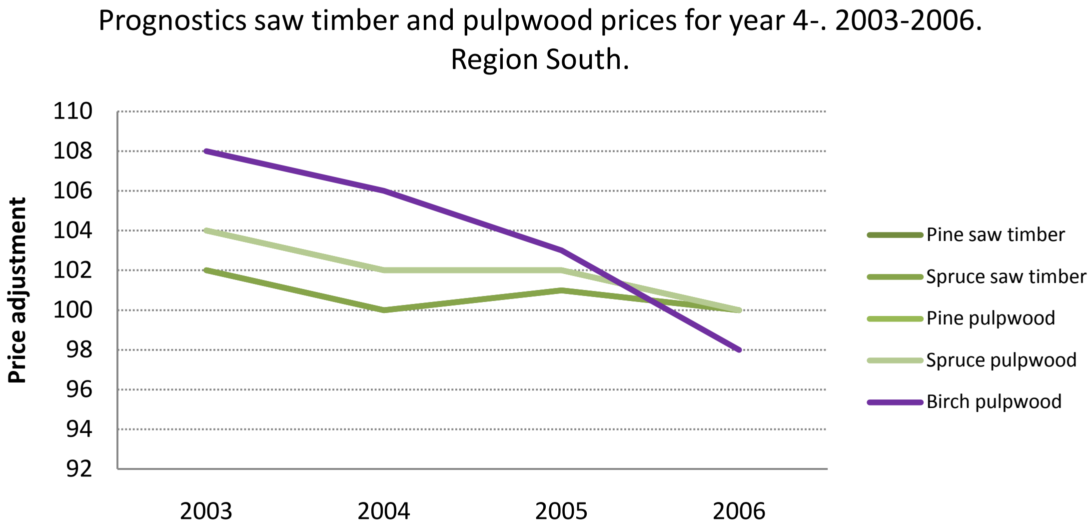
Classifications of productive forest land

Level of cultivation	Code	Detail
Cutover	K1	Cutover that has not yet been reforested or not fully reforested
		Same as K1 but with seed-trees
	K11	Cutover that has been reforested
	K2	Same as K2 but with seed-trees
	K21	
Clerance forest	R1	Reforested forest which has passed the point where help measures can be put in action (height < 1.3 m)
	R11	Same as R1 but with seed-trees
	R2	Juvenal forest (height ≥1.3 m and Ø < 10 cm)
	R21	Same as R2 but with seed-trees
Thinning forest	G1	Young thinning forest (Ø > 10cm and younger then lowest allowed age of thinning)
	G2	Old thinning forest (Same as G1 but has reached lowest allowed age)
Final felling forest	S1	Felling ready forest (have reach lowest allowed age)
	S2	Recommended for final felling
	S21	Same as S2 but with seed-trees
	S3	Forest that should not be harvested (due to environmental and cultural reasons, similar to other protected classes)
Low producing forest	E	Forest with low growth rate

Source: National Land Survey of Sweden 2005

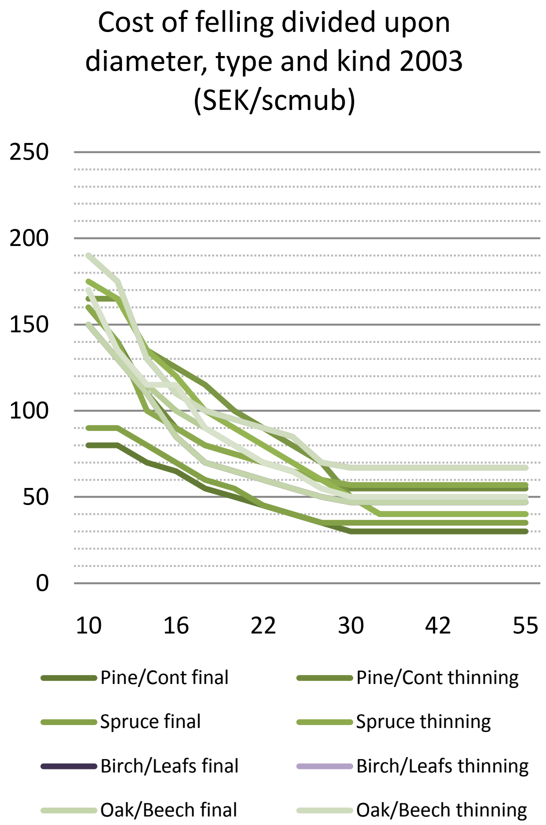
Appendix 4

Future prices

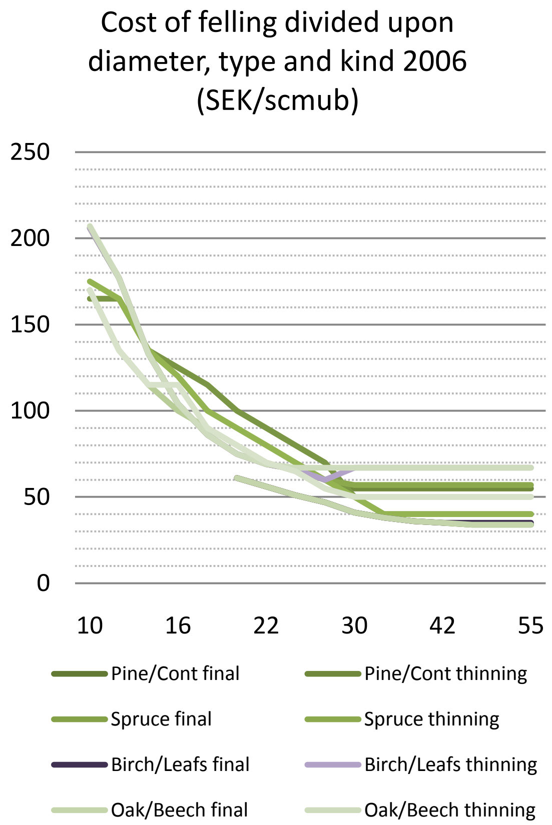


Source: National land survey

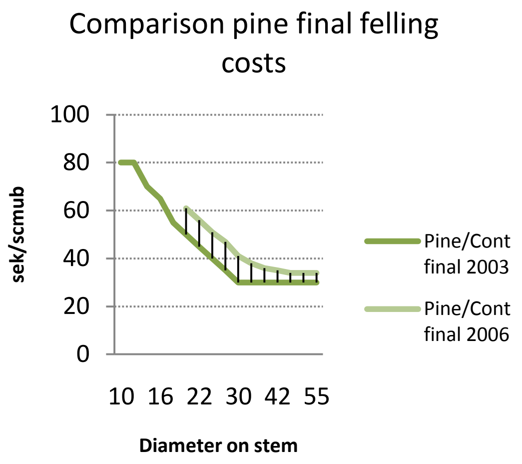
Extraction costs

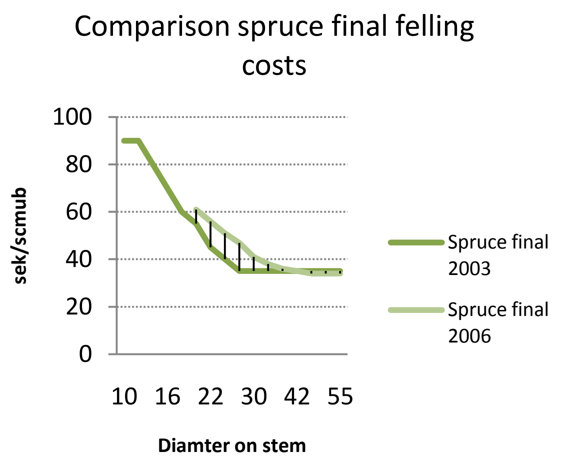


Source: LRF-Konsult



Source: LRF-Konsult

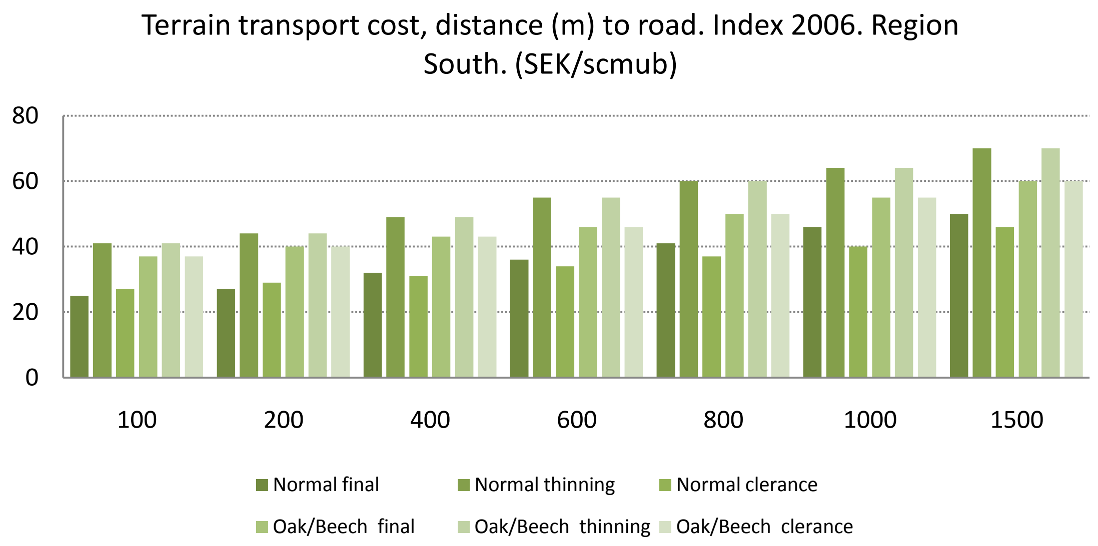




Source: LRF-Konsult

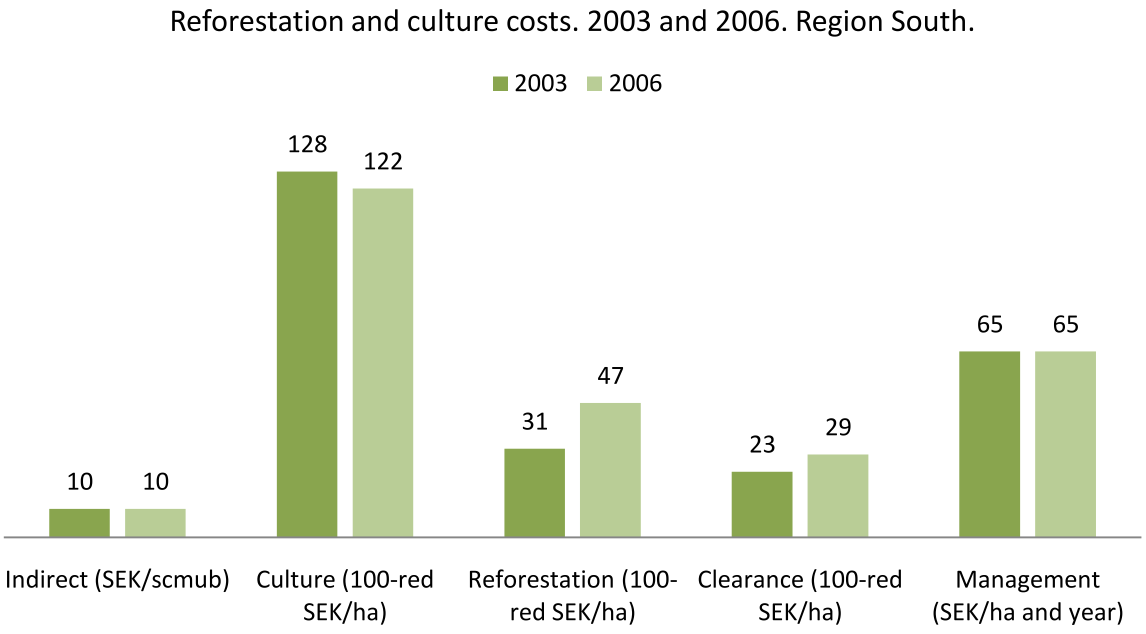
Source: LRF-Konsult

For terrain transportation we will use the south of Sweden 2006 index for all transactions. The cost increases with distance and somewhat more so for Oak/Birch.



Source: LRF-Konsult

Silviculture and reforestation cost



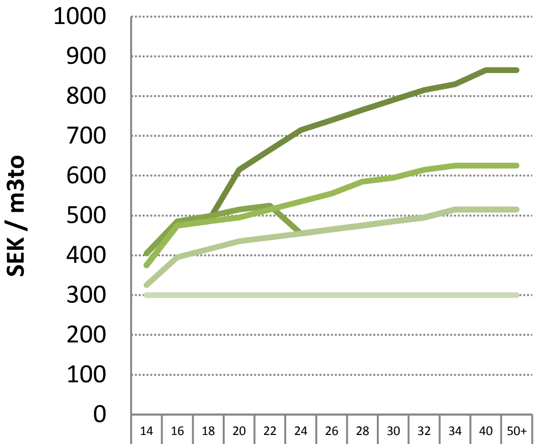
Source: National land survey

Tables

Since the model bases some of its factors, such as extraction percentage and growth, on empirical surveys it differs depending on where you are in the country and at what period in time they have been done. In order to make the model more exact a wide variety of different tables are used to adjust for this. Two such general tables are the county table and quality tables. They are rarely changed so we will use the same set of tables for our entire sample. We will use the *länstabell Jkpg:s län (u.k.)* as the county table and the *Standard for F VMR99* as quality table which was standard settings for this time period.

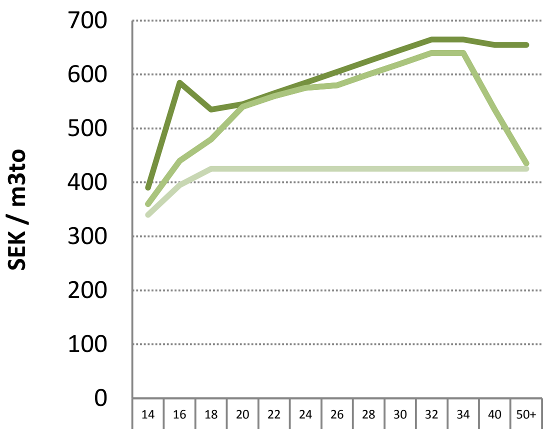
Extraction cost in detail 2003 – All data refers to Jönköping county, region South

Pine sawtimber delivery prices aug



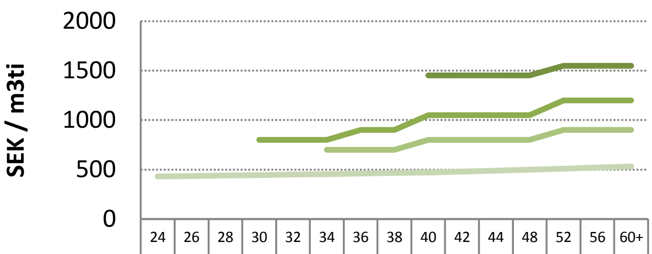
	14	16	18	20	22	24	26	28	30	32	34	40	50+
Quality 1	375	475	485	615	665	715	740	765	790	815	830	865	865
Quality 2	405	485	498	515	525	455	465	475	485	495	515	515	515
Quality 3	375	475	485	495	515	535	555	585	595	615	625	625	625
Quality 4	325	395	415	435	445	455	465	475	485	495	515	515	515
Quality 5	300	300	300	300	300	300	300	300	300	300	300	300	300

Spruce sawtimber delivery prices aug



	14	16	18	20	22	24	26	28	30	32	34	40	50+
Quality 1	390	585	535	545	565	585	605	625	645	665	665	655	655
Quality 2	360	440	480	540	560	575	580	600	620	640	640	535	435
Quality 3	360	440	480	540	560	575	580	600	620	640	640	535	435
Quality 4	340	395	425	425	425	425	425	425	425	425	425	425	425

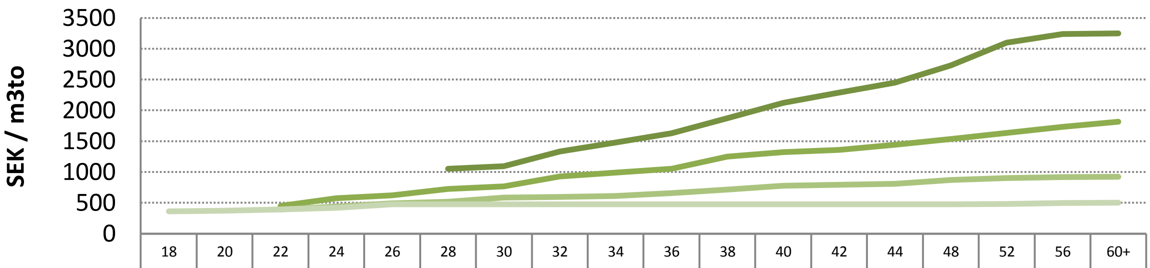
Beech sawtimber delivery prices aug



	24	26	28	30	32	34	36	38	40	42	44	48	52	56	60+
Quality 1									1450	1450	1450	1450	1550	1550	1550
Quality 2				800	800	800	900	900	1050	1050	1050	1050	1200	1200	1200
Quality 3						700	700	700	800	800	800	800	900	900	900
Quality 4	430	435	440	445	450	455	460	465	470	480	490	500	510	520	530

Pulpwood prices aug 2003. (SEK / m3fub)

Oak sawtimber delivery prices aug



	18	20	22	24	26	28	30	32	34	36	38	40	42	44	48	52	56	60+
Quality 1						1050	1095	1330	1480	1630	1870	2120	2290	2450	2730	3100	3240	3250
Quality 2			450	575	620	725	765	930	990	1050	1250	1320	1360	1440	1535	1635	1730	1815
Quality 3			395	440	490	515	585	595	610	655	715	775	795	810	870	900	915	920
Quality 4	360	370	390	420	475	475	475	475	475	475	475	475	475	475	475	480	495	500