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Society's costs of occupational injuries within Swedish agriculture

Andreas Schroeder

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Andreas Schroeder

Supervisor: Yves Rene Surry, Swedish University of Agricultural Sciences, Department of Economics

Examiner: Sebastian Hess, Swedish University of Agricultural Sciences, Department of Economics

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Abstract

In this thesis, society's costs from occupational injuries within Swedish agriculture are computed. Relative little previous research with an economic view at the problem has been done on this area before. This thesis estimated costs from output loss, health care and fatal accidents caused by occupational injuries. It is done by using data collected from different databases and from this, connecting costs from occupational injuries to the number of injuries that occurs. The results gave a total annual cost of 225 million SEK. Of this, 90 million SEK is output loss, 15 million SEK is health care costs and 120 million SEK is costs from fatal accidents. This result shows a substantially smaller total cost than Jordbruksverket's estimates in 2007.

Sammanfattning

Syftet med detta arbete var att beräkna de samhällsekonomiska kostnaderna som uppstår vid arbetsskador inom det Svenska jordbruket. Tidigare ekonomisk forskning på området är begränsad, och utförs oftast istället inom andra ämnen än nationalekonomi.

I arbetet uppskattades kostnader från produktionsbortfall, sjukvård och dödsfall till följd av arbetsolyckor. Det gjordes genom att samla in statistik från olika databaser och koppla samman kostnader med antalet olyckor som sker. De ekonomiska teorier som användes var främst från produktionsekonomi. Teorierna kombineras med vad tidigare studier kommit fram till gällande var kostnaderna från arbetsskador uppstår.

Resultatet visade en årlig kostnad på 225 miljoner och ska beaktas med försiktighet. Av detta var 90 miljoner SEK produktionsbortfall, 15 miljoner sjukvårdskostnader och 120 miljoner konstander från dödsfall. Resultatet visar en anmärkningsvärd lägre kostnad än vad Jordbruksverket uppskattade kostnaderna till år 2007.

Denna studie kan vara till nytta för olika intressegrupper. Dessa kan vara politiker, försäkringsbolag och jordbruksorganisationer såsom LRF.

Abbreviations

Arbetsmiljöverket - Swedish work environment authority

Jordbruksverket - Swedish board of agriculture

KPP – kostnad per patient – cost per patient

MC - Marginal cost

MP - Marginal product

MR - Marginal revenue

MRPL - Marginal revenue product of labor

SAERG - Swedish Agency for Economic and Regional Growth

SALAR - Swedish Association of Local Authorities and Regions

SCB - Statistics Sweden

Skatteverket – Swedish tax agency

SLU - Swedish University of Agricultural Sciences

STA - Swedish transport administration

SWEA - Swedish work environment authority

TC - Total cost

TR - Total revenue

VSL - Value of a statistical life

WTP - Willingness to pay

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1. Introduction

The research question of this thesis is "what are the society's costs of occupational injuries within Swedish agriculture?"

In 2007 the Swedish board of agriculture estimated society's cost of accidents within the agricultural sector to 2 – 3 billion SEK annually. Their research was done on behalf of the government and the results were published in Jordbuksverket (2007). In the report, calculations on society's cost of accidents within agriculture were made based on the same figures used when calculating the costs of traffic accidents. The methods used to retrieve these figures are often based on "willingness to pay"-studies which are used to estimate the value of a statistical life (VSL)(Jordbruksverket, 2007).

Some questions and problems with the approach were raised in by Jordbruksverket (2007). For example if valuation of accidents within agriculture could be done in same way as with traffic accidents. The report did also encourage a more thorough analysis of the society costs of accidents within agriculture.

The objective and purpose of this thesis is to find a value of society's cost of occupational injuries within Swedish agriculture. The specific objectives are: i) to find a value on the production losses caused by occupational injuries within Swedish agriculture; ii) to find a value of the health care costs caused by occupational injuries within Swedish agriculture; and iii) to find a value on society's costs caused by fatal work accidents within Swedish agriculture.

The agricultural sector, as any other sector, has problems with health risks for the worker. These can be accidents, illness and even death caused by bad working conditions. The problem in Sweden and other countries is that agriculture is in the top, next to for example the construction sector when it comes to work related health problems. Only in work related fatal accidents, agriculture stands for 20 – 25 % of the total number in Sweden (Arbetsmiljöverket, 2013). This could be for many reasons, for example farms are often single-employee firms or all the employees are within the family. This could lead to farmers working alone more than other which could increase the risk for occupational injuries (Arbetsmiljöverket, 1982). Another factor could be that a self-employed don't have the same responsibility to others as in a case with many employees. Another significant problem which is unique for agriculture is the health risk for children living at the farm because their natural playground also is a work place, with all the health risks that follow.

Work related health problems does not only lead to suffering and costs for the individual, but is also a cost for the society in form of health care and output losses. Actions could be done to prevent this problem but these could be costly. The government, insurance companies and other interest groups have restricted budgets and it is therefore important to know which projects that should be prioritized. If preventive actions against work related health problems

costs less than for example insurance payments it would be wise to go through with these projects.

1.1 Outline

This thesis is based on empirical research and will use secondary data from different statistical databases such as Eurostat, Statistics Sweden (SCB) and Swedish work environment authority own database. For this research data will be collected on mainly two elelementssubjects. These are:

- Number of accidents per year related to Swedish agriculture, how severe and what type of physical damage these accidents are.
- The costs of these accidents which then can be summed to the society's total cost. This thesis will focus on health care costs and production losses. The production losses will be represented by income and reduced work capacity.

The method to analyze the data will be to connect different accidents to the costs they bring and then sum the total costs. It will be based on economic theory and previous research on society's cost of bad working conditions.

The outline of this thesis is as follows: A literature review on previous research on the subject and a theoretical framework including economic theory which will be the foundation to the procedures in the following section, Material, methods and procedures. This section will explain how and why things are done in a certain way based what was learned in the theoretical framework and literature review. The next section is Results which will show the outcome of this work. The thesis's last section is Discussion and conclusions where the research question and objectives will be discussed together with the results and new insights and remaining problems will be addressed.

1.2 Limitations

Limitations are done in this thesis to make it more feasible with the given time limit.

The first limitation is geographical. This thesis will focus on the work related health problems within Swedish Agriculture. This thesis will therefore use data regarding accidents and costs in Sweden.

The next limitation is that this thesis will only address costs from production loss that occur within agricultural production. Output loss from, for example household tasks, will therefore be excluded. Costs from health- and work rehabilitation are also not included in this thesis togheter with costs from decreased quality of living.

Costs from occupational disease will not be computed in this work. This is due to lack of data and the problem to track an occupational disease to a certain workplace.

2. Literature Review

When doing the literature review for this thesis it became clear that relative little research is done on society's cost from occupational injuries which authors on the subject also states in their own research (Sjögren Lindquist and Wadensjö, 2010).

2.1 Costs from work related health problems

Sjögren Lindquist and Wadensjö (2010) made a systematic review on this subject on behalf of the Swedish work environment authority (SWEA) where they examine what society's costs are for work environment problems. The costs occur in various ways and are mainly represented by two posts; output loss and health care costs. Output loss happens when an individual can't work for a shorter or longer period, gets a decreased working capacity or may not do household task as a result from work related health problems. Health care costs are represented by medical treatment costs and rehabilitation. Further costs that could occur from work environment problems are for example physical and psychological suffering and material damage are. (Sjögren Lindquist and Wadensjö, 2010)

Most of the work related health problems comes from work accidents. These are also easier to connect to a certain work place. Work related health problems can also come from transport accidents to and from work and sickness caused by the work environment. Transport accidents can be related to individuals working but not to risks on a certain work place. Sickness caused by work environment can, but is harder to connect to a certain workplace. This is because an individual could have been working on several different work places before a diagnosis is established. It is therefore not certain that the individual's current work place is the cause of the sickness. (Lindquist and Wadensjö, 2010)

Lindquist and Wadensjö (2010) explain how the costs from work accidents and sickness are shared between different groups in the Swedish society. The costs from production loss are shared between the individual, the employer and different types of social- and employee insurances. Even with a good insurance the individual's income will most likely be reduced. In Sweden the health care is financed from taxes and therefore health care costs from work accidents and sickness are paid by the taxpayers. (Lindquist and Wadensjö, 2010)

Even though Sjögren Lindquist and Wadensjö (2010) discuss this problem in a broad context they did calculations on health care costs for occupational injuries after the location they happened. For "agricultural area" they computed the health care costs to 15 million SEK in 2008. They did this by doing own calculations based on the KPP database.

2.2 Society's cost of occupational injuries

Miller and Gailbraith (1993) did a study were they estimated workplace injury costs in the U.S. They estimated the annual cost to $140 billion. Their estimate included $17 billion in medical and emergency services, $60 billion in lost productivity, $5 billion in insurance costs, and $62 billion in lost quality of life. They pointed out that the costs from workplace injuries in motor vehicle crashes are almost six times the workplace injury average.

Miller and Gailbraith (1993) included several different variables in their accounting. These were medical and emergency services, wage and household work, adminastrative and legal costs, workplace disruption and quality of life. Miller and Gailbraith (1993) state that willingness to pay studies is the modern approach to injury costing and that "it values life from what people state they are willing to pay, or more commonly what they actually pay for small gains in their survival probability". They argued that these values can be estimated from the wage premiums that compensate workers for taking risky jobs. They also point out that these values can be very uncertain. Their final result after including all these costs is shown in Table 1.

Table 1: Costs from occupational injuries

Cost category	**All injury**
Medical/emergency srvs.	$17 B
Wage/fringe work	42 B
Household work	7.5 B
Work disruption	10 B
Legal and administrative	5.4 B
Quality of life	62 B
Total	$140 B

Source: Miller and Gailbraith (1993)
Note: B=billions

It can be seen in Table 1 that lost quality of life is a large part of the total costs. Costs like household work, work disruption and legal and administrative together also makes out a substantial part of the total sum, larger than Medical/emergency services.

2.3 Value of life

A part of the economic problem of occupational injuries is how to value life. Several methods for doing this have been used and the research on the subject is more substantial than costs from occupational injuries.

Viscusi (2003) based estimates of value of life on standard hedonic wage framework. In the regression, he used a worker's hourly wage rate as the dependent variable. The explanatory variables used was personal and job characteristics, death risk based on the worker's occupation and industry, injury risk for the worker's industry and injury risk times replacement rate. The estimated results indicated a value of statistical life of $ 4, 7 million.

The Swedish transport administration (STA) does every year review and publish calculation values, which are used for societal economics calculations in the transport sectors. These publications include VSL's for fatal accidents caused by traffic accidents. Society's cost of a traffic accident comes from partly a risk valuation that should reflect the costs for the victim due to loss of life or health but also costs in form of health care, administration, property damage and production loss (STA, 2015).

VSL is a measure of the net benefit loss in society due loss of a life. VSL is determined from the marginal willingness to pay and is dependent on for example the initial level of risk that is used when valuing a risk reduction (STA, 2015). Viscusi (2003) used hedonic pricing in the labor market to retrieve a VSL while STA uses values based on results from willingness to pay (WTP) -studies (Hultkrantz and Svensson, 2008). In these studies, participants answer several hypothetical questions on how much they are willing to pay for risk-reductive measures (Hultkrantz and Svensson, 2008). By doing so, the individual's demand curve is revealed. The problem with WTP-studies is that the questions are hypothetical, which makes it hard to predict if the participants will act the same way in real situations (Hultkrantz & Svensson, 2008).

2.4 Costs from occupational injuries in agriculture

As stated in the introduction, similar research to this thesis was done in 2007 by the Swedish board of agriculture. The research was done on behalf of the government and the results were published in Jordbruksverket (2007). In the report, calculations on society's cost of accidents within agriculture were made, based on the same figures used when calculating the costs of traffic accidents (Jordbruksverket, 2007). The methods used to retrieve these figures was based on "willingness to pay"-studies which are used to estimate VSL (Hultkrantz and Svensson, 2008).

The Swedish board of agriculture estimated society's cost of accidents within the agricultural sector to 2 – 3 billion SEK annually. According to the report, society's costs of accidents occur in various ways such as resource use in health care, production losses and humane

costs. To set a value on life and damages they used key figures published by the institute of communication analysis (SIKA). This institute were closed in 2010 but until then they provided figures used in this type of calculations. The report from 2007 used the following figures shown in Table 2 provided by SIKA.

Table 2: Valuation of different categories of damages in traffic accidents. Year 1999 price level.

Catagory of damage	Costs, SEK
Death	14 300 000
Severely injured	2 600 000
Slightly injured	150 000
Property damage	13 000

Source: SIKA, 2000

The figures from Table 2 were used together with statistics on accidents within Swedish agriculture from Statistics Sweden (SCB) and Swedish University of Agricultural Sciences (SLU) to make an estimate of society's costs. For various reasons they canceled out Property damage. They also made some assumptions to compensate for the fact that the willingness to report accidents is low. The calculations resulted in an estimate shown in Table 3.

Table 3: Costs of accidents in agriculture

Category of damage	Number of accidents according to absence from work	Estimated costs, million SEK
Death	10	155
Severely injured	1 100	3100
Slightly injured	550	90
Total		**3 345**

Source: Jordbruksverket (2007)

Several problems with this approach were brought up in the report. First of all, the figures in Table 2 are calculated based on traffic accidents and may not be the same for agriculture. Another problem brought up is that the average age within agriculture is higher than the average population and this makes them believe that the costs could be overestimated. Because of this and by taking some caution their final estimate of society's cost of accidents within Swedish agriculture is 2 – 3 billion SEK.

Some final questions were raised in the report as also stated in the introduction of this thesis. For example if valuation of accidents within agriculture could be done in same way as in traffic accidents. The report also encourages a more thorough analysis of the society costs of accidents within agriculture and the size of these.

3. Theoretical framework

The following chapter includes the economic theory which is used in this thesis. The theory is chosen after what was learned from costs of work related health problems in the literature review.

3.1 Output loss

An inefficient firm suffers from output loss. This means that firms do not produce output to the lowest possible cost (Pindyck and Rubinfeld, 2013).

Firms produce output by using different inputs. The level of output can be expressed as a production function where output *Y* is a function of capital *K* and labor *L.* A widely used form of the production function is the Cobb-Douglas. The general form of the Cobb-Douglas is shown in Equation 1:

$$Y = AK^{\alpha}L^{\beta} \tag{1}$$

Where *A* is the total factor productivity, α is the factor elasticity of capital and β is the factor elasticity of labor (Pindyck and Rubinfeld, 2013).

With a given level of output firms will try to minimize costs for producing that output. If the firm succeeds with minimizing the costs it means that the firm is efficient (Pindyck & Rubinfeld, 2013). If an employee at an efficient firm becomes a victim of a work accident or sickness which reduces that employees working capacity, a company that have no obligations to its employees could just hire someone else to do the same job and continue to be efficient. In Sweden, employers do have obligations towards its employees. Employers are bound to pay for example sick pay if an employee becomes ill (Försäkringskassan, 2014). This leads to larger costs for the producer if an employee becomes a victim of a work accident that reduces working capacity. The employer will have to pay sick pay to the worker and choose to either reduce output and loose revenues, or hire another worker to stay on the same level of output. By the sick pay the output loss is transferred from the employee to the employer. If the firm is not prepared for these costs it will lead to inefficiency since it is not minimizing it costs towards a given level of output.

Occupational injuries could be seen as random adverse shocks that causes output loss for the producer. Though the producer can, by implementing prenventive actions against accidents reduce the risk of these adverse shocks. These preventive actions are in insurance theory known as effort. Effort is what the insurance taker uses from the own wealth to reduce the risk of having to use the insurance (Nicholson and Snyder, 2008). Since this effort come with a cost, the economic problem for the producuer to be cost efficient becomes similar to cost efficent abatement from environmental economics. Cost efficient abatement of a pollutant occurs when the marginal abatement cost is equal to the marginal cost of damage (Brännlund and Kriström, 2012). In a case with occupational injuries instead of a pollutant, the producer

could implement all kinds of measures to reduce the number of injuries to zero but this could be costly and probably not cost efficient. Instead the producure should reduce the risk of occupational injuries until the marginal cost of effort is equal to the marginal cost of the risk. This will be cost effiecent and is shown in Figure 1.

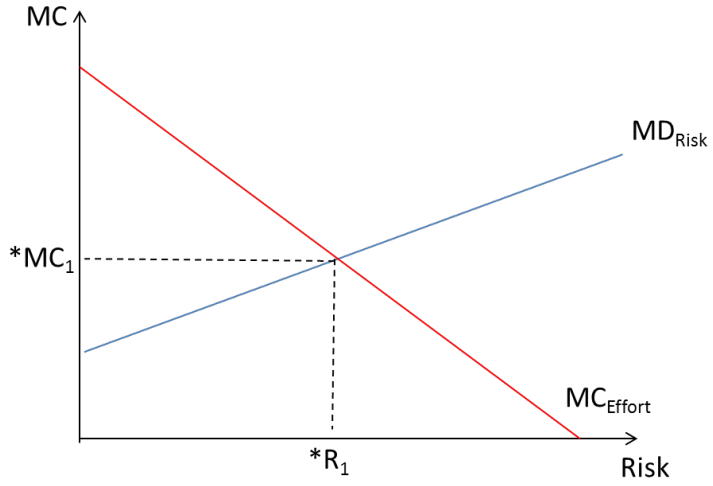

Figure 1 Cost efficient reduction of risk

In optimum MC_{Effort} is equal to MD_{risk}. The risk is reduced to the $*R_1$ and the MC is $*MC_1$. In this point, the producer has a cost-efficent risk reduction.

If the producers either have a reduced or increased effort compared to the optimum in Figure 1, it is not cost efficient and this will cause output loss.

3.2 Marginal revenue productivity theory of wages

This thesis will use wages as a measure of productivity. This will then be used to calculate the output loss from sick leave.

The change in total revenue earned by the firm as a result from hiring one extra unit of labor is expressed as the marginal revenue product of labor (MRP_L). From the firm's production function in Equation 1 it is expressed as in Equation 2:

$$MRP_L = MP_L \; x \; MR$$
$$where$$
$$MP_L = \frac{\partial Y}{\partial L}$$
$$and$$
$$MR = \frac{\partial (TR)}{\partial Y} \qquad (2)$$
$$which\ gives\ MP_L \; x \; MR = \frac{\partial TR}{\partial L}$$

A profit maximizing firm will produce output until marginal costs (MC) is equal to marginal revenure (MR). This means that the firm will add one extra unit of labor until MRP_L is equal to the cost of labor, the wage (w). This is expressed as in Equation 3:

$$MRP_L = w$$
$$MP_L \; x \; MR = w$$
$$MR = \frac{w}{MP_L} \tag{3}$$
$$where \; \frac{w}{MP_L} \; is \; the \; MC \; which \; gives \; the \; profit \; maximizing \; rule:$$
$$MR = MC$$

In a perfect competitive market the wage will be equal to the value of the output produced by that unit of labor (Pindyck and Rubinfeld, 2013). In other words this means that the wage for a specific worker corresponds to the value of what that worker produces. Notice that wage in this case is the cost of labor, which means that if there are additional costs of hiring workers such as employer contribution etc., these have to be taken into account as well.

3.3 Model over Society's costs

A model for society's yearly costs of work related health problems within Swedish agriculture have been developed from the above given theoretical framework and the literature review. The costs included in the model are health care costs, output loss and costs from deaths.

$TC_{society} = TC_{health\ care} + TC_{production\ loss} + TC_{deaths}$
$where$
$TC_{health\ care} = \alpha_i X_i + \ldots\ldots\ldots \alpha_n X_n$
$TC_{production\ loss} = wy$
$TC_{deaths} = \gamma Z$

In this model α_i is the health care cost of physical damage type *i*, and X_i is the number of cases of type *i*. *w* is the cost of an agricultural worker per hour and *y* is number of work hours lost due to work accidents and occupational diseases. Total costs from deaths are given by γ which is a VSL and *Z* the number of deaths.

4. Materials, methods and procedures

As stated in the introduction, this thesis is based on empirical research and used secondary data collected from different statistical databases. The time period used was from 2008 to 2012. The following bullet points give an overview on what data that have been collected:

- How many work accidents that have occurred during the specific years.
- The severity of these accidents in terms of how many days of sick leave the victim required.
- Average income and age of an agricultural worker.
- What type of physical damage these accidents caused.
- The average health care cost of the different types of physical damages.
- Number off fatal accidents.
- A VSL for fatal accidents.
- Value of output from agriculture in Sweden.

From what was learned in the literature review, costs from health care and fatal accidents will be included in this thesis when computing the total costs. To compute these values, it requires a large collection of data and this will be outside the scope of this thesis. Therefore health care costs and VSL for fatal accidents will be retrieved from secondary sources.

The data was processed in Microsoft excel by calculating the average from 2008 to 2012 and connecting the costs from health care and production loss to severity and physical damage. The result from this was inserted in the model developed in the theoretical framework.

4.1 Work accidents and the severity

The data on the number of work accidents and the severity of these was collected from the databases Eurostat and Swedish work environment authority's own database. This was used to estimate *y* in the following equation:

$$TC_{output\ loss} = wy$$

The data from the two databases was compared to see which one gave the most complete quantitative information. The benefit with the data from Eurostat's database was that it included a larger number of observations and more specific information about the severity of the accidents. The downside was that the data included observations from agriculture, forestry and fishing industry and that a large number of the observations were unspecified in terms of severity. The data from Swedish work environment authority had fewer observations and were unspecific on the severity. Also it only had observations from 2010 to 2014. The benefit was that the observations could be specified to agriculture. Why the datasets differ in number of observations is unclear.

The procedure to solve the problems with multiple industries and unspecified observations was to use the observations from Eurostat and use Swedish work environment authority dataset to gain a distribution on the number of accidents between agriculture, forestry and fishing. From this an estimate could be done on how many of the accidents in Eurostat's dataset that have occurred within agriculture. The procedure to solve the problem with unspecified observations in Eurostat's data set was to use the percentage distribution of the specified observations and from this distribute the unspecified observations in the same proportions.

After the procedures that excluded accidents from forestry and fishing and the distribution of unspecified observations, the data had to be further processed to retrieve the number of work hours lost per year due to work accidents. The severity was given in different time span such as 4 – 6 work days lost and 1 – 3 months lost. To retrieve a specific number of days lost the median of every time span was calculated, for example 5 was for the time span 4 – 6 days. The median was then multiplied with the number of work accidents that had that classified severity, and the number of work hours in a day, in this case eight hours. The severity classification "Permanent incapacity" was instead of calculating the median, treated as how many years an average agricultural worker has left until retirement. The retirement age used was 65. The number of work hours lost from every type of severity was then summed up to the total number of work hours lost on average in a year which gives the variable *y*.

4.2 Income and age

The data on the average income and age of an agricultural was collected from the database Statistics Sweden (income) and the Swedish board of agriculture (age). This was used to estimate *w* in the following equation:

$$TC_{output\ loss} = wy$$

This thesis will use wages as a measure of productivity and to derive the output loss from work accidents. The dataset on income was given in average hourly earnings for workers within agriculture, forestry and fishing. As stated in the theoretical framework, *w* is the cost of the input labor and therefore all the costs of hiring an extra unit of labor have to be taken into account. This is why the data on age have been collected, because employer fees vary with age in Sweden (Skatteverket, 2015).

To compute the cost per hour of an agricultural worker an internet based calculator on hiring costs provided by Swedish Agency for Economic and Regional Growth (SAERG) was used. The calculator uses expected monthly salary of the worker and the age of the worker as variables to estimate the costs (Verksamt, 2015). To compute the expected monthly salary the average hourly earnings of an agricultural worker was multiplied with the number of work hours in a month. The number of hours used was 167 and the average age used was 55 (www, Karlsson, 2013). The estimated monthly costs given by the calculator was then divided by 167 to retrieve cost per hour, *w*.

4.3 Physical damage and health care costs

The data on what type of physical damage the accidents caused was collected from the same databases as the data on severity. The datasets had the same benefits and problems as the one on severity. To be consistent the procedure to solve this problem was the same. The data was used to estimate X_i in the following equation:

$$TC_{health\ care} = \alpha_i X_i + \ldots\ldots \alpha_n X_n$$

The average health care costs of the different types of physical damage werer retrieved from the Swedish KPP-database and were used to estimate α_i in the above equation. KPP means cost per patient and the database is provided by the Swedish Association of Local Authorities and Regions (SALAR). Different diagnoses can be searched in the database and from there an average cost per treatment can be retrieved for different types of injuries. Because of unspecific information regarding the physical damage in Eurostat's dataset the mean of the average cost of multiple suitable diagnoses were used. The injury named "Other not elsewhere mentioned" were given the average cost of the other injuries. See appendix for more specific information on which diagnoses that were used for the different types of physical damage.

4.4 Fatal accidents and VSL

The number of fatal accidents within agriculture was the least problematic data to find and could be retrieved from several sources. The data used was from Swedish work environment authority. The numbers of fatal accidents is Z in the following equation:

$$TC_{deaths} = \gamma Z$$

As stated in the theoretical framework, estimating a VSL for fatal accidents are outside the scope of this thesis. Therefore the same method will be used as Jordbruksverket (2007) did for fatal accidents. They used values from Swedish transport administration (STA). These values are developed to be used for estimating costs from traffic accidents and may therefore cause an error term. The current VSL for fatal traffic accidents was collected from STA (2015) and dates from 2010 and is 22 328 000 SEK. This value will be γ in the above equation.

4.5 Society's cost of work accidents

After the procedures to find the costs of output loss, health care and deaths, the values of these were inserted into the main model developed in chapter 3. This generated a result in form of society's total cost of occupational injuries within Swedish agriculture. The result was then compared with the collected data on the value of output in Swedish agriculture.

5. Results

In this section the results from this research are presented. The results were obtained by using the methods and procedures described in the previous chapter. First the result from computing the costs from output loss is presented, followed by the computed health care costs and then the costs from fatal accidents. These sub results are then merged in the main model and the total costs for society is presented.

5.1 Total costs from production loss

The total costs from output loss due to work accidents were computed by following the steps in previous chapter. The result from this is shown in Table 4.

Table 4 Output loss

SEVERITY	Average	Average*	$Average_1$	y
Total number of accidents at work with more than 3 days of absence and fatal accidents at work	587			
More than 3 days lost (4 days absence or more)	578	578	385	
4 - 6 days lost	24	49	33	1312
7 - 13 days lost	32	66	44	3542
14 - 20 days lost	65	134	89	12116
21 days lost - 1 month lost	45	93	62	12600
1 month lost - 3 months lost	74	151	101	48273
3 months lost - 6 months lost	26	54	36	38960
Permanent incapacity (to work)	16	32	21	385399
Fatal accident	9			
Unspecified	296			
			Total	502201
Hourly wage + employer charges (*w*)	180			
$TC_{production\ loss}$	90396249			

Source: Based on data from Eurostat, SCB, SWEA, SAERG and own calculations.
Notes: Average is the average of the number of accidents with the given severity within agriculture, forestry and fishery.
Average is the average of the number of accidents with the given severity with "Unspecified" distributed.*
$Average_1$ is the average of the number of accidents with the given severity within agriculture.
y is the total number of work hours lost on average with the given severity.

The figures in the column "Average" were computed from Eurostat's dataset and were given by the years 2008 - 2012. Figures appearing in the column "Average*" were the result of distributing the unspecified accidents and excluding fatal accidents since costs from these are presented separately. In the column "$Average_1$" accidents from forestry and fishery were excluded by using the dataset on severity from SWEA. The total number of accidents within agriculture, forestry and fishing was compared with only agriculture. This showed that agriculture represented 2/3 of the total number of accidents and 1/3 was therefore removed from the values in Average* to retrieve $Average_1$. A problem was that SWEA dataset only contains observations from 2010 to 2014, which means that data 2008 and 2009 were missing and those for 2013 and 2014 were off the time limit. Therefore the years 2010 to 2014 were first tested to see if the distribution of accidents between agriculture, forestry and fishing

varied much between the years. The test showed that this was not the case. See appendix for SWEA dataset and test.

The column *y* in Table 4 shows the total number of work hours lost on average for every level of severity. It was computed by taking figures appearing in column "Average$_1$" times the median of the severity in days times 8 hours. In Table 4 it can be seen that the total number of work hours lost on average per year from 2008 – 2012 is 502 201 hours, which gives the variable *y* in the main model.

The final step before total costs from production loss could be calculated was to compute variable *w* in Table 4, which is the labor cost per hour. This was done by using the online calculator provided by SAERG. For this the average hourly earnings of a worker within agricultural, forestry and fishing were needed which is shown in Table 5.

Table 5: Average hourly earnings for a worker within agriculture, forestry and fishing in SEK.

	2008	2009	2010	2011	2012	Average
Average hourly earnings	127,3	130,1	133	140,6	140,1	134,22

Source: SCB

After following the steps described in the chapter 4.2, an approximated monthly cost of 30 000 SEK was generated which gave the variable *w* the value 180 SEK.

After defining the variables *y* and *w* the total costs from production lost gave the following calculation and result also shown in Table 4:

$$TC_{output\ loss} = wy = 180 * 50\ 2201 = 90\ 396\ 249\ SEK$$

This result means that the average yearly value of the total output lost, due to occupational injuries within Swedish agriculture from 2008 until 2012, amount to approximately 90 million SEK.

5.2 Total costs from health care

The next step was to compute the total costs from health care. The result from this is shown in Table 6.

Table 6 Health care costs.

INJURY	Average	Average*	$Average_1$ (X_i)	α_i	$\alpha_i X_i$
Wounds and superficial injuries	123	144	96	23826	2290582
Bone fractures	187	219	146	30624	4476032
Dislocations, sprains and strains	117	137	91	30624	2800512
Traumatic amputations (Loss of body parts)	14	16	11	96372	1054553
Concussions and internal injuries	13	15	10	15910	161660
Burns, scalds and frostbites	7	8	5	108085	591362
Poisonings and infections	2	2	2	19763	30894
Drownings and asphyxiations	0	0	0	x	x
Effects of sound, vibration and pressure	0	0	0	x	x
Effects of temperature extremes, light and radiation	0	0	0	x	x
Shocks	2	2	2	27090	42348
Multiple injuries	18	21	14	198337	2790396
Other not elsewhere mentioned	10	12	8	61181	478198
Unspecified	85				
$TC_{health\ care}$	14716538				

Source: Based on data from Eurostat, SWEA, KPP and own calculations.
Nortes:
Average is the average of the number of accidents with the given injury within agriculture, forestry and fishery.
Average is the average of the number of accidents with the given injury with "Unspecified" distributed.*
$Average_1$ is the average of the number of accidents with given injury within agriculture

Figures appearing in columns “Average”, “Average*” and “$Average_1$” in Table 6 were computed the same way as those presented for the same columns in Table 4. Although in Table 6 the figures appearing in column “$Average_1$” also represent the value of X_i in the main model. The values for α_i correspond to the different health care costs collected from the KPP-database. Notice that injury “Other elsewhere not mentioned” has been given the average value of the rest of the injuries. Also “Bone fractures” and “Dislocations, sprains and strains” have been given the same value. This is because these are in the same diagnosis group in the KPP database. α_i were multiplied with X_i to retrieve the column $\alpha_i X_i$. These were summed in the bottom row which gave the following calculation and result also shown in Table 6:

$$TC_{health\ care} = \alpha_i X_i + \ldots\ldots \alpha_n X_n = \sum_i^n \alpha_i X_i = 14\,716\,538\ SEK$$

This result means that the average yearly costs of health care, due to occupational injuries within Swedish agriculture from 2008 until 2012, amount to approximately 15 million SEK. This result complies well with Sjögren Lindquist and Wadensjö (2010) caclulations on health care costs from occupationial injuries occurred at an agricultural area.

5.3 Total costs from fatal accidents

The final step before computing society's total costs from work accidents within Swedish agriculture was to find the costs from fatal accidents. The result from this is shown in Table 7.

Table 7 Costs from fatal accidents

Year	Fatal accidents
2008	7
2009	6
2010	3
2011	10
2012	1
Total	27
Average(Z)	5,4
VSL(γ)	22328000
TC_{deaths}	120571200

Source: Based on data from SWEA, STA and own calculations.

Table 4 shows the number of fatal accidents within agriculture per year from 2008 to 2012. The average value represents *Z* in the main model and VSL represents γ. When these variables were defined the total costs from fatal accidents were computed by the following calculation and the result is also shown in Table 7:

$$TC_{deaths} = \gamma Z = 22328000 * 5{,}4 = 120\,571\,200 \text{ SEK}$$

This result means that the average yearly costs from fatal work accidents within Swedish agriculture from 2008 until 2012, amount to approximately 120 million SEK. This value is given when using a VSL provided by STA which is intended to be used on traffic accidents.

5.4 Society's total costs

With the sub results presented above, society's total cost could be computed by using the main model. This gave the following calculations and result:

$$TC_{society} = TC_{output\,loss} + TC_{health\,care} + TC_{deaths}$$
$$TC_{society} = 90\,396\,248 + 14\,716\,538 + 120\,571\,200$$
$$TC_{society} = 225\,683\,986$$

The result of this thesis with its limitations shows that society's total cost from occupational injuries within Swedish agriculture amounts to approximately 225 million SEK annually. This result shows significant lower costs than Jordbruksverket (2007).

With the total costs calculated, it was compared with the value of output in agriculture. The value of output is shown in Table 8.

Table 8: ***Production value at producer prices in Swedish agriculture. Given (million SEK.)***

	2008	2009	2010	2011	2012	Average
Value of output	46206	42797	47653	50182	52802	47928

Source: Jordbruksverket and own calculations.

With the average value given in Table 8, $TC_{society}$ is computed to less than 1 % of the value of output.

5.5 Problems with the approach

There are several problems with the methods and procedures in this thesis. The already mentioned problems with the data regarding severity and physical damage may cause errors in the results. The first error can occur when the accidents from forestry and fishing are excluded from Eurostat's data set. Since the two datasets already differ in number of observation, it's possible that the distribution between agriculture, forestery and fishing also differ. The second error can occur when the unspecified observations are distributed among the specified observations.

When the median is used to specify the numbers of days lost for the different levels of severity it may cause error in the result since the distribution within the different time spans is unknown. Also giving the severity "Permanent incapacity" the value of years until retirement for an agricultural worker my cause errors since even a few years of variations have a large impact on the output loss.

The data on income regards agriculture, forestry and fishing and may therefore not be the correct average income for an agricultural worker. A large part of the workforce within agriculture is self-employed and their income likely varies from an employed worker which could lead to an underestimate of the output loss. When using the online calculator for hiring costs, average age is used and this could cause similar problems as with self-employment, an agricultural worker may be younger than a self-employed farmer.

With limited knowledge within the field of medicine and relative unspecific details from the dataset on what type of physical damage that comes from different accidents, problems occurs when connecting α_i to Xi. The optimal costs from diagnoses may not be connected to the different injuries. The KPP-database provides average costs for diagnoses and when computing the average of several average costs it may cause statistical errors that can affect the final outcome of the total health care costs.

The final problems with the method occur when using a VSL for traffic accidents when calculating costs from fatal work accidents within agriculture. This problem is also discussed by Jordbruksverket (2007). They argue that there may be a different in the valuation of risk reduction between traffic accidents and work accidents within agriculture. Therefore the total cost from fatal accidents computed in this thesis should be interpreted with caution.

6. Discussion and conclusions

The research question of this bachelor thesis was "what are the society's costs of bad working conditions within Swedish agriculture?" The specific objectives were: i) to find a value on the production losses caused by occupational injuries within Swedish agriculture´; ii) to find a value of the health care costs caused by occupational injuries within Swedish agriculture; and iii) to find a value on society's costs caused by fatal work accidents within Swedish agriculture.

With the limitations given in the introduction the answer to the research question is that the annual cost of bad working conditions within Swedish agriculture is 225 million Swedish crowns. For the objectives, the value of the production losses is 90 million SEK annually, the costs from health care is 15 million SEK annually and the costs from fatal accidents is 120 million SEK annually. This corresponds to less than 1 % of value of output in Swedish agriculture during the same years.

The research question and the objectives have been met but the given values should be interpreted with caution. In the results section, problems with how these values were obtained were discussed and it is clear that some of the procedures to handle inconsistency in the data can cause errors in the final result. Even so, the results can give an indication on how big the economic problem is with occupational injuries in agriculture. Noticeable though is that the procedures to connect injuries to their health care costs could be problematic but the result from this was very much in line with the costs found by Lindquist and Wadensjö (2010).

If the result of this thesis is compared with what was found by Jordbruksverket (2007) it is clear that the difference in costs is large. They estimated society's costs to 2 – 3 billion SEK annually which is ten times larger than what was found in this thesis. This could be for many reasons. First of all Jordbruksverket (2007) had a much larger number of observations, almost five times the number of observations in this thesis. Hopefully this is because the number of accidents per year has drastically declined since Jordbruksverket did their study. But also the data used in this thesis could also be incomplete. Second, as mentioned several times, Jordbruksverket used a different approach which they argued themselves, that it is not free from possible errors. But most likely their method led to that more categories of costs were included.

Miller and Gailbraith (1993) included several posts in their calculations which were not included in this thesis. Especially the costs from decreased quality of life were not included but they were a large part of the total cost in their result. If the distribution of costs from occupational injuries found by Miller and Gailbraith (1993) is the same in Swedish agriculture, the result of this thesis is significantly underestimated and the true value could then be approximately 500 million SEK. With this value in mind and the larger number of

observations in Jordbruksverket (2007), the gap between the result of this thesis and Jordbruksverket's result becomes smaller.

This thesis has generated new insights in how large society's costs are from bad working conditions within Swedish agriculture. It could be used as a complement to Jordbruksverket (2007). This thesis uses another method which partly answers the final questions raised in Jordbruksverket's report.

The amount of previous research on this topic is limited and hopefully this thesis and other studies done is only the beginning of a larger interest in this problem from economists in Sweden and internationally. The result generated from this thesis could be used by several interest groups in Sweden such as LRF, SWEA, SLU, and JTI in their work of improving the working conditions in agriculture. Governmental departments could use the information when overviewing the priority of different projects in the Swedish labor market and health care sector. Also insurance companies can receive incentives to set higher demands on regulations and to help their customers in preventive measures.

This thesis has left some questions open regarding the costs of bad working conditions within Swedish agriculture. The costs from occupational disease are still unknown and several costs from both diseases and injuries were not included in this thesis.

It would be interesting with further research on this topic. When assessing the costs from bad working conditions in agriculture, Miller and Gailbraith (1993) could be used as a framework on what costs to compute and include in the model. This type of research would be more time consuming and require more substantial data than the research in this thesis. For a more complete picture of the problem, further research could also include occupational diseases. Estimated costs from occupational injuries could also be used in a cost-benefit analysis on preventive measures.

References

Books

Brännlund, R. & Kriström, B. (2012). *Miljöekonomi* Lund: Studentliteratur AB

Nicholson, W. & Snyder, C. (2008) *Microeconomic Theory.* Mason: Thomson Higher Education.

Pindyck, R.S. & Rubinfeld, D.L. (2013) *Microeconomics*. New Jersey: Pearson Education

Reports

Arbetsmiljöverket (1982). *Ensamarbete.* Stockholm: Arbetsmiljöverket (AFS 1982:3)

Arbetsmiljöverket (2013). *Arbetsskador 2013.* Stockholm: Arbetsmiljöverket (Rapport 2014:1)

Jordbruksverket (2007). *Motverka olycksfall i lantbruket*. Jönköping: Jordbruksverket (Rapport 2007:8)

SIKA (2000). *Kalkylvärden i sammanfattning*. Stockholm: Statens institut för kommunikationsanalys (SIKA Rapport 2000:3)

Sjögren Lindquist, G. & Wadensjö, E. (2010). *Samhällsekonomiska kostnader för arbetsmiljöproblem*. Stockholm: Arbetsmiljövereket (Rapport 2010:2)

Trafikverket (2015). *Samhällsekonomiska principer och kalkylvärden för transportsektorn.* Borlänge: Trafikverket (ASEK, 5.2.)

Papers

Miller, T.R. & Galbraith, M. (1993). Estimating the costs of occupational injury in the United States. *Accident Analysis Prevention*., Vol. 27, No. 6, pp. 741-747, 1995

Viscusi, W.K. (2003). *The Value of Life: Estimates with Risks by Occupation and Industry*. Harvard. John M. Olin Center for Law, Economics, and Business. Discussion no. 422.

Web pages

Försäkringskassan (2015-05-13). *Om sjuklön.* http://www.forsakringskassan.se/arbetsgivare/sjukfranvaro/sjuk_1_14/om_sjuklon/ [2015-05-13]

Hultkrantz, L. and Svensson, M. (2008). Värdet av liv. *Ekonomisk Debatt.* Nr 2 2008, årgång 36.

Karlsson, A.M (2013-06-25). *Heltidsjordbrukarnas medelålder är 55 år.* https://jordbruketisiffror.wordpress.com/2013/06/25/heltidsjordbrukarnas-medelalder-ar-55-ar/ [2015-05-13]

Skatteverket (2015-05-13). *Arbetsgivaravgifter*. http://www.skatteverket.se/foretagorganisationer/arbetsgivare/socialavgifter/arbetsgivaravgifter.4.233f91f71260075abe8800020817.html [2015-05-13]

Verksamt (2015-05-13). *Räkna ut vad en anställd kostar.* https://www.verksamt.se/alla-e-tjanster/rakna-ut/rakna-ut-vad-en-anstalld-kostar [2015-05-13]

Appendix

Table 9
Occupational accidents in agriculture, Sweden

Orsak	År	2010	2011	2012	2013	2014	Total	Average
Elektricitet, explosion eller brand		< 5	< 5	< 5	< 5	< 5	**9**	
Damm, gas, rök eller vätskor		< 5	< 5	< 5	< 5	< 5	**15**	
Material föll, rasade, brast eller sprängdes		23	21	13	20	18	**95**	
Fordonskollision, påkörd, skadad av förem		130	130	129	126	122	**637**	
Fall av person		34	47	49	33	47	**210**	
Slog emot något, trampade på något vass		< 5	6	6	7	14	**37**	
Feltramp, lyft eller annan överbelastning		20	15	29	23	16	**103**	
Hot eller våld, chock, rädsla			< 5	5	9	7	**25**	
Annan orsak		< 5	< 5	< 5	< 5	< 5	**8**	
Total		**217**	**227**	**240**	**225**	**230**	**1 139**	**228**

Source: SWEA and own calculations

Table 10
Occupational accidents in agriculture, forestry and fishing, Sweden

Orsak	År	2010	2011	2012	2013	2014	Total	Average
Elektricitet, explosion eller brand		< 5	< 5	< 5	< 5	< 5	**11**	
Damm, gas, rök eller vätskor		< 5	< 5	< 5	< 5	7	**20**	
Material föll, rasade, brast eller sprängdes		35	28	29	40	33	**165**	
Fordonskollision, påkörd, skadad av förem		188	187	175	166	178	**894**	
Fall av person		68	78	79	68	77	**370**	
Slog emot något, trampade på något vass		7	8	7	10	17	**49**	
Feltramp, lyft eller annan överbelastning		34	28	41	37	25	**165**	
Hot eller våld, chock, rädsla		< 5	5	6	10	8	**32**	
Annan orsak		< 5	< 5	7	< 5	< 5	**18**	
Total		**344**	**341**	**351**	**340**	**348**	**1 724**	**345**

Source: SWEA and own calculations

Table 11
How large part of the accidents within agriculture, forestry and fishing that occurred in agriculture in %.

Orsak	År	2010	2011	2012	2013	2014	Total	Average
agri. accidents. /all accidents		**0,631**	**0,666**	**0,684**	**0,662**	**0,661**	**0,661**	**0,661**

Table 12
Diagnosis codes from the KPP-database used for estimating health care costs.

INJURY	MDC and DRG
Wounds and superficial injuries	MDC: 09 DRG: 280, 281
Bone fractures	MDC: 08 DRG: 250, 251, 253
Dislocations, sprains and strains	MDC: 08 DRG: 250, 251, 253
Traumatic amputations (Loss of body parts)	MDC: 08 DRG: 213
Concussions and internal injuries	MDC: 01 DRG: 031, 032
Burns, scalds and frostbites	MDC: 22 DRG: 457, 458, 459, 460, 472
Poisonings and infections	MDC: 21 DRG 449, 450
Shocks	MDC: 05 DRG 127
Multiple injuries	MDC: 24 DRG 884, 885, 886, 887
Other not elsewhere mentioned	Average of above