Swedish University of Agricultural Sciences
Faculty of Natural Resources and Agricultural Sciences
Department of Economics

Barriers to convert to organic farming and the role of risk

- An empirical application on Swedish data

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Barriers to convert to organic farming and the role of risk.
-An empirical application on Swedish data

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Abstract

To understand the motives, and perhaps more importantly the *barriers,* for farmers to convert from conventional to organic farming is of great interest for policy makers as well as for academics. In Sweden and in other EU countries, proposed targets of the area in organic farmland have failed to be reached in spite of different kinds of policy measures. Most studies agree that the average profitability seems to be comparable to or better in organic than in conventional farming. This would indicate that there must be other factors of importance which can explain the low particiapation rate. A higher perceived risk in organic farming with respect to yield and price is frequently brought up as a potential explanation within a qualitative framework. If farm income risk is higher in organic farming than conventional, a rational risk-averse individual would only convert if compensated by a sufficient risk premium. Therfefore, the observed hesitation of farmers to convert would be rational if income from organic farming is more risky and the risk premium is insufficient in compensating for this risk.

The aim of this study is to explore the impact of yield and price *risks* in organic farming by analyzing *risk-adjusted* net returns. This is carried out through performing Excel based and mathematical programming analyses, using data that describe a typical organic crop farm and a conventional crop farm in southern Sweden. Farm characteristics are characterized based on previous studies while crop characteristics are taken from official statistics. The specific objective is to analyse two questions:

- Based on historical data, is organic farming more risky than conventional farming?
- Based on historical risk adjusted returns, should a rational profit maximizing farmer convert to organic farming?

The conclusion from the analysis is that, based on the empirical results, the organic crop farm has a lower risk and a higher income than the conventional one. The higher risk-adjusted net returns suggest that an organic risk premium is not motivated and that a rational farmer should convert from conventional crop farming to organic crop farming. However, the results show that when crop net returns are disaggregated into yield and price, the risk is higher for the organic crop farm. The generally lower risk in net returns for the organic crops could depend on the stronger negative correlation between yield and price for the organic crops than the conventional ones. The common perception of a generally higher risk in organic crop farming could then be explained by a disproportionate focus on price and yield exaggerating the *perceived risk* leading to non-rational behaviour.

An underestimated risk factor in the analysis could be the conversion period having a substantial negative impact on the farm risk as well as income. However, the empirical results suggest that the organic support payments compensates adequately with regard to the income *level* as well as the income *risk*. Other risk factors that may explain the higher risk associated with organic faming and not included in the study are the learning curve when adapting organic practices, regulations and political risk.

Sammanfattning

Flertalet studier tyder på att ekologiskt lantbruk verkar mer lönsamt än ekologiskt vilket väcker frågan varför inte fler väljer att ställa om från konventionell til ekologiskt lantbruk.

Högre risk till följd av förbud mot konstgödsel och bekämpningsmedel samt en liten outvecklad marknad för ekologiska produkter är argument som lyfts fram som möjliga förklaringar vilket därmed skulle motivera en riskpremie. Syftet med studien är att undersöka riskens roll i det ekologiska lantbruket genom att analysera två frågor:

- Baserat på historiska data, är ett ekologiskt lantbruk mer riskfyllt än ett konventionellt lantbruk?
- Baserat på den historiska risk-justerade nettoinkomsten, borde en rationell lantbrukare ställa om från konventionellt till ekologiskt lantbruk?

Analysen baseras på Excel-baserade beräkningar och optimeringar som tillämpas på svenska data. Dessa data karaktäriserar ett ”typiskt” ekologiskt respektive konventionellt växtlantbruk i södra Sverige

Resultaten tyder på att *nettoinkomsten* för ett ekologiskt växtlantbruk har *lägre risk* och bättre lönsamhet. En rationell lantbrukare borde därmed ställa om till ekologiskt. Däremot visar resultaten att den enskilda risken i *avkastning* och *pris* är *högre* för ekologiska grödor än för konventionella. Detta kan dels förklaras av förhållandet mellan pris och avkastning för ekologiska grödor som är mer negativt korrelerade än för de konventionella och därmed dämpar inkomstrisken. En annan möjlig förklarande faktor kan vara produktionskostnaden per hektar. Lantbrukarens fokus på avkastning, som i viss mån är påverkbar, och priser, kan därmed överdriva den uppfattade risken och leda till ett icke rationellt beslut.

Riskfaktorer som underskattas i studien kan dock vara omställningsperioden med ekologisk avkastning och konventionella priser samt inlärningskurvan för att lära sig nya metoder. Andra faktorer kan vara regelverk och politisk risk.

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1 Introduction

This chapter will give a brief introduction to the problem background and motivate why this subject is of interest. The aim and objective with the study is stated followed by a discussion of limitations. The chapter ends with an overview of the outline of the study.

1.1 Problem background

The interest in organic products and farming methods has grown out of concern for a sustainable environment, food security and animal welfare (Padel and Lampkin 2007). A majority of the governments in the industrialized countries have chosen to recognize the social benefits of organic farming, and have promoted the conversion from conventional to organic farmland with different policy measures. In spite of these policy measures, the conversion rate is perceived as too slow and even seems to have stagnated in recent years in Sweden as well in EU (Schwarz 2010, Swedish Government 2006). This has drawn attention from policy makers as well as from academic researchers asking the question:

What are the motives and barriers for farmers to convert from conventional to organic farming?

International studies have addressed the question from different angles (see for example Daugbjerg et al. 2011, Gleirscher 2008, de Lauwere et al. 2004, Kerselaers et al. 2007, Khaledi et al. 2010, Flaten et al. 2010). A common denominator for the results in these studies seem to be that idealistic reasons are important for taking the decision to convert but perceived income risk factors associated with yield and price seem important for not converting from conventional to organic farming. These results are in line with views expressed in a Swedish study (Cahlin et al. 2008).

The concept of risk is frequently expressed as an important factor in the literature. However, the number of studies trying to deal with risk factors in a quantitative aspect, are rather limited. One of the studies primarily dealing with risk factors concludes that price risk, due to an undeveloped market, and yield risk, due to restrictions on fertilizers and pesticides, play an important role for the decision to convert or not (Acs et al. 2009). The authors in this study argue that in stable situations, i. e. disregarding risk factors, organic farming may as studies indicate, be more profitable than conventional farming. They conclude that for a risk-neutral farmer, while the optimal choice would be to convert to organic, a risk-averse farmer would need stronger incentives to convert than generally perceived in many of the studies that omit risk. This view gets some support from Kerselaers et al. (2007) arguing that the positive results of economic conversion potential must be put into the perspective of higher risk and liquidity problems during the transition period. Kuminoff and Wossink (2010) further confirm the importance of risk factors affecting the conversion decision with extra attention on support payments. They find that higher expected revenues will increase the conversion rate. However, if the farmers perceive the support payments as uncertain, they will wait with the conversion until the uncertainty has diminished.

There are a couple of studies supporting the notion of perceived risk as a conversion that suggest that organic farmers are less risk-averse than conventional (Kallas et al. 2010, Koesling et al. 2004). Based on a questionnaire on Norwegian farmers, the results in Koesling et al. (2004) indicate that organic farmers perceived themselves to be less risk-averse than conventional farmers. For both conventional and organic farmers, crop prices and yield variability were the two top-rated sources of risk, followed by institutional risks. The authors conclude that the importance of institutional risks implies that policy makers should be cautious about changing policy capriciously and they should consider strategic policy initiatives that give farmers more long-term reliability.

Using somewhat different approaches there are a number of studies trying to deal with the incentives for farmers to convert with varying results. However, the results do not seem to be contradictory, rather complementary and seem to reveal some key points that may be worth some extra effort to explore:

- In a static setting disregarding time dynamics, risk factors and risk attitudes, organic farming seems to be more profitable *on average*.
- Taking into account the extra strenuous conversion period seems to hamper the positive results of organic farm net income and income risk.
- The restrictions on commercial fertilizers and pesticides lead to more vulnerability and greater variability in yield due to pest outbreaks which may destroy the whole harvest and hence a higher yield risk.
- The organic market is still small, implying that even minor changes in supply and demand could have large price effects, hence a higher price risk.
- The support scheme is meant to compensate for insufficient price premiums and higher risks but could be perceived of as unreliable and maybe even add risk.

If organic farming is more risky, this could explain why farmers hesitate to convert even if it seems profitable. The suggestion that organic farmers as less risk-averse could then still be part of the explanation of why some have adapted organic practices. To better understand the barriers for a farmer to convert, the inclusion of risk in the analysis may be fruitful.

1.2 Problem

Farm profitability analyses based on Swedish data generally conclude that *on average*, net income is higher in organic production than in conventional production, even in some cases when the organic support payment is not included; see for example (Cahlin et al. 2008, Rosenqvist 2003). These results are in line with international studies suggesting that net income is comparable to or higher in organic than in conventional farming (Acs et al. 2007, Nieberg and Offermann 2008, Offermann and Nieberg 2000, Kerselaers et al. 2007).

If seemingly more profitable, why don’t more Swedish farmers choose to convert to organic?

1.3 Aim

The aim of this study is to add the dimension of risk to net farm income in evaluating the decision to convert to organic farming. A perceived higher risk in organic farming could be an important barrier for conversion and be at least one of several possible explanations to the hesitation to convert. If organic farming in reality is more risky than conventional, it would rather be the rational choice for a risk-averse farmer not to convert unless compensated by a sufficient risk premium.

The objective of this study is to compare organic and conventional farm net incomes with respect to the *risk-adjusted* net returns, hence add the role of risk in *yield* and *price* to the analysis. The risk aspect may be separated into crop-specific characteristics and farm characteristics where different combinations of crops are available. The specific questions to be addressed are:

- Based on historical data, is organic farming more risky than conventional farming?
- Based on historical risk adjusted returns, should a rational profit maximizing farmer convert from conventional to organic farming?

Government support to organic farming in recognition of its wider benefits began in the 1980's and has since then become more and more an instrument of agricultural policy (Stolze and Lampkin, 2009). To find the appropriate level of support in practice is a balancing act and important for farmers themselves as well as for society and taxpayers. The compensation should be sufficient enough to motivate a conversion while excessive support could substitute for the market mechanism and be counterproductive (Lampkin & Padel, 1994). Increased knowledge about the role of risk could be an important input to the work of developing a more efficient policy.

The first question will be addressed by using comparative statics on different crops and using this to calculate net farm income for two comparable "typical" farms, one organic and one conventional. The second question will be addressed with an expected income variance (EV) analysis using Excel-based mathematical programming. The result from this type of analysis is of course sensitive to selected crops, farm size and crop rotations. The different farm characteristicsis are based on previous studies and expertise advice from the Swedish Board of Agriculture and the program Agriwise a data base which provides services to consultants and farmers (www, Agriwise, 2011).

The results are not to be interpreted as truly representative for an individual farm. They are conditioned on the assumptions of a typical farm represented by official statistics from a certain geographical area and the selected time period. In addition, potentially important factors such as investment costs and social welfare are omitted.

The EV model framework was selected based on the combination of theoretical relevance and the straightforward empirical application. This framework allows the inclusion of risk without growing too complex with regard to the number of input variables and necessary restrictions.

An alternative approach would be to use some type of bio-economic model that is rather reflected in a growing number of international studies (Janssen et al. 2010). These models are generally used to determine effects from policy changes, technical innovations and other factors on specific farm categories (Zander et al. 2008, Janssen et al. 2010, Kerselaers et al. 2007, Acs 2007a) Due to the complexity of inputs in many of the models, the trade-off is often to exclude the time and risk dimension. One exception can be found in Acs et al. (2009) where a discrete stochastic dynamic utility efficiency (DUEP)-model is developed that incorporates time dynamics as well as risk factors and farmers risk attitudes.

Another approach would be to use a statistical model to find empirical relationships of conversion rate and possible risk factors affecting the conversion decision.

The selected method seemed to be the best choice given the many data and time limitations. Looking forward, the analysis may still be of social benefit and scientific relevance by studying if risk factors should be given more attention or not in the context of organic farming. This is especially relevant because, when the present Rural Development Program ends in 2013, it will be replaced by a new policy program.

The thesis outline will from here continue with some background to give an overview of organic farming policy in Sweden. Next, the theoretical chapter presents a literature review that focuses on the concept of risk in decision making. The empirical section starts with a description of the methods used and data collection followed by a presentation of the results from the comparative statics, farm profitability calculations and the expected value variance (EV) -model. Next the results are analysed and discussed with regard to theory and other studies. The paper ends with conclusions and suggestions of further studies.

2 Organic Farming in Practice

This chapter gives an explanation of the major differences betwen organic and conventional practices and briefly discusses the Swedish policy regarding organic farming together with a historical review and the present situation.

2.1 What is Organic farming?

The International Federation of Organic Agriculture Movements (IFOAM) has agreed to the following definition:

> "Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and good quality of life for all involved" (www, IFOAM, 2011).

In practice, the key characteristics of organic farm management include restrictions of commercial (inorganic) fertilizers and pesticides and greater concern for animal welfare in production. Lampkin and Padel (1994) summarize the main differences from conventional farm management as:

- Instead of using chemical fertilizers, crop nutrition is provided by the use of legumes and biological nitrogen fixation and by recycling crop residues and livestock wastes.
- Instead of using chemical pesticides for controlling weeds and pest the organic farm relies on crop rotation, natural predators and green manuring.
- The management of livestock pay full regard to their behavioural needs and animal welfare issues with respect to nutrition, housing, health, breeding and rearing

2.2 Organic farming guidelines

According to the Swedish Government organic agriculture implies that cultivation and animal husbandry are carried out in such a way that reflects concern for the environment and uses fewer resources. It should also rely on a high level of self- subsistence (Swedish Government 2006). In Sweden there are roughly three different categories of organic farming with somewhat different conditions:

- KRAV-certified organic
- EU-certified organic
- Non-certified organic

The main differences between the three are the level of regulation and eligibility to participate in support programs. A certification according to EU or KRAV rules allows the farmer to use the respective labels and to receive the highest level of governmental support (Clarin et al. 2010). KRAV is based on EU rules but is stricter in certain areas, animal welfare among others (www, KRAV, 2011). While EU-certified farmers are not allowed to use the KRAV label, KRAV farmers may use both labels (www, Swedish Board of Agriculture, 2011). KRAV, a small association run by the Swedish Organic Farmers, was established in 1985 and was the only certification body in Sweden at the time (www, KRAV, 2011). Facing alternative certification labels they market the KRAV label as reliable and extra animal and environmentally friendly compared to EU-organic, motivating a higher price premium (www, KRAV, 2011).

The non-certified organic farming has traditionally been farmers applying for organic support without certifying their farms. In the beginning of the organic development the most common sales channel for organic products was selling directly to consumers. This way the farmer could avoid the wholesale stage, taking a share of the profit and a non-certified organic farmer could still call the products organic and claim organic price premiums. From 1 July 2010, EU rules state that only certified farms are allowed to market their product as organic, using the labels from the EU or KRAV (www, European Commission 7, 2011).

The focus on certified organic production aims to promote the supply of labeled organic production in order to increase the interest from the wholesale side (Clarin et al. 2010). The adjustment in levels of support is also a way to promote organic production in areas where production differs substantially from the conventional farming production and thereby requires larger support. The new program implies that from 2010 the support levels will be adjusted every two years (www, Swedish Board of Agriculture, 2011). The aim is to align the support with the market in the EU, which means that it can be adjusted either up or down. *In this study the term organic will be used as an equivalent to certified organic.*

To convert the farm from conventional to certified organic, the farm needs to undergo a conversion period of two years for crop production, but the period is shorter for livestock (www, Swedish Board of Agriculture, 2011). During this period, production is controlled by an inspection body. During the conversion period the farmer is eligible for the highest level of financial support (the level for certified production), but the products cannot be marketed as organic and hence not sold with an organic premium. The commitment period for certification is five years.

2.1 Political targets

Organic agriculture in Sweden developed during the 1980’s and grew in magnitude in the 1990’s (Swedish Government 2006). In 1994, the Swedish Parliament agreed on a target, which stated that 10% of the agricultural land area in Sweden should be organically farmed by the year of 2000 (Swedish Government 1999). This target was achieved already in 1999 and the Swedish Parliament decided upon new targets to be reached in 2005. The new targets implied a doubling of organic agricultural land to 20% and in addition that 10% of animal production should be organically produced. The 2005 target was not reached and therefore the Swedish Parliament renewed the target, now to be reached in 2010 (Swedish Government 2006). The Parliament also added stricter conditions to organic product, which implied that the share of organic farming should be *certified* according to EU-standards or Swedish KRAV. The support levels were at the same time roughly doubled for certified farmers compared to non- certified (Clarin et al. 2010). However, the support has not motivated enough farmers to convert in order to reach the government target. According to available statistics for 2009, the certified organic farmed area is about 12.5% of total cultivated land (Swedish Board of Agriculture 2010).

3 Theoretical perspective and literature review

This chapter begins with a brief discussion of organic farming and the rational behind governmental support. The literature review deals with studies using different approaches to investigate the motives and barriers for farmers to convert to organic farming. The theorethical framework deals with with farm income and risk. The key issue is how the farmers' decision is affected by the risk per se and the personal risk attitude. The chapter ends with a discussion of identified main sources of risk in crop production.

3.1 Economics and organic farming

3.1.1 Organic farming and market failure

The concept of organic farming receives significant attention from policy makers in the industrialized countries (Stolze and Lampkin 2009). The governments seem to agree that state support to organic farming could be justified because of its positive benefits for the society. Assuming that organic farming provides benefits for the society, this could be translated to an economic value (Lampkin and Padel 1994). This value should be recognized by an efficient market and hence find the efficient price on the organic product. In general organic products are more expensive due to higher per unit production costs. These costs stem from lower yields that are a result of restrictions on the use of fertilizers and pesticides and stricter rules regarding animal husbandry (larger space requirements and possibilities to move in open space). In an efficient market the price on the organic product would account for the associated benefits and costs with a price premium with respect to the conventionally produced products. From an economic point of view the positive benefits for society not accounted for by the market should be regarded as an external effect. There are different measures dealing with market failures aiming to internalize these external effects and in the case of organic farming different kinds of subsidies are the most widespread. The argument for subsidies is to temporarily support this kind of production until the products can compete on the same market conditions as conventional products. That can happen when the relative production costs for these products have fallen, which could for example happen when there is large scale production or improved technologies and available knowledge.

The stagnating growth rate for organic production in Sweden is not only an isolated Swedish event but is recognized in a majority of the EU member states. At the same time, organic support in general has not decreased (Schwarz et al. 2010). The relationship between higher support levels and larger organic areas is not unequivocal. For instance, the UK has the lowest share of organic farms receiving financial support but still has a relatively large share of organic farmland, 4% of the total agricultural area (European Commission 2010). Other countries that have a relatively large area of organic production are Austria, Italy, Spain and Greece. Some of these also have relatively high support (Schwarz et al. 2010).

This raises several questions about how efficient the governmental support really is and what the factors are, that drive the conversion decision. These are important questions to answer from different aspects. The government needs to find policy measures that are as efficient as possible without wasting taxpayers' money. The farmers adapting organic methods should be sufficiently compensated for the market's inability to include all the external effects in the market price without distorting the market mechanisms completely.

3.1.2. What are the motives and barriers for converting to organic farming?

Studies dealing with the relationship between support measures and conversion rates show ambiguous results. Daugbjerg et al. (2011) find a relationship between some of the policy measures introduced in the UK and Denmark. Gleirscher (2008) on the other hand, argues that the current direct policy measures in Austria cannot be considered as effective instruments to further increase the organic sector in the country.

Although early adapters of organic farming were driven by non-economic reasons the financial motives for converting to organic farming have appeared to become more important (Lampkin and Padel 1994, Flaten et al. 2006). A number of studies suggest that the average profitability is higher in general in organic farming than in conventional farming (Acs et al. 2007, Kerselaers et al. 2007).

Kerselaers et al. (2007) simulated a model on 685 conventional Belgian farms and concluded that the economic potential from conversion to organic production is higher than generally perceived. They conclude that surveys reveal that economic potential is underestimated and that this hampers conversion behavior. The profitability of organic farms is confirmed by Nieberg and Offermann (2003) among others. They find that the price premium on organic products compensates for the lower yields. However, in another study they also conclude that the variability in profit between organic farms is large (Nieberg and Offermann 2008). The factor which seemed to lead to success was the management ability of the farmers, above all in the area of marketing. Further, the same authors argue that that policy measures, including the organic support payments of the 1992 CAP reform, have ensured the relative competitiveness of organically managed systems (Offermann and Nieberg 2000).

The importance of support payments is highlighed by Zander et al. (2008). Their results showed that support accounts for 10-30% of family farm income plus wages in the Western European countries and up to 75% in some of the newly joined countries. This would indicate that organic net farm income is rather dependent on organic support payments. They stress the observed trend of increased policy dependency over the recent years, arguing that organic farms are becoming more vulnerable to policy changes. This would also suggest that the market is still unable to compensate for the benefits and costs associated with organic products.

The ambiguous relationship between subsidies and conversion rates has led to attempts to take a wider approach to identify potential factors not always reflected in official statistics. These analyses are typically based on surveys and interviews. In general the motives to convert to organic farming are divided into economic and non-economic factors while the barriers to convert are generally divided into production, market, institutional and social barriers (Lampkin and Padel 1994).

The importance of non-economic motives to convert are found by de Lauwere et al. (2004) who interviewed farmers in the Netherlands. The respondents put forward idealistic motives as the most important reason to convert. Flaten et al. (2006) separated organic dairy farmers that were interviewed into the “old guard” (organic for about ten years or longer) and “newcomers” (organic for not more than five years). On average the most frequently mentioned motives for conversion were food quality and professional challenges. However, when separating the groups the farmers in the old guard were more strongly motivated by food quality and soil fertility/pollution issues than the newcomers.

Flaten et al. (2010) analyse survey data among Norwegian farmers to identify reasons for quitting organic. Items relating to economic and regulation issues were the primary reasons for opting out of organic farming. They argue that the most efficient way to reach the goals for organic production set by many governments, is to reduce the number of farmers opting out of organic farming. Some advice they provide is to construct a better targeted support scheme instead of providing support to all organic farms, irrespective of their needs or interests. Higher output prices or lower input prices, primarily through private-sector initiatives to facilitate market innovations are also ways to encourage farmers to remain organic. They also strongly recommend that those involved in organic legislation should be cautious about making changes in standards too frequently, suddenly and unpredictably.

Ferjani, Reissig and Mann (2010) carry out a similar study in Switzerland and draw similar conclusions: economic and regulatory reasons are important for opting out. Among the conventional farmers the fear of weed problems is also an important concern for conversion. Higher organic price premiums, higher support payments and stable organic guidelines are all factors that would motivate conversion to organic farming.

From an economic perspective, a key factor that inhibits the conversion to organic production involves the conversion process as this requires a restructuring of the farm business (Lampkin and Padel 1994). During the two years of the process the farmer may face a lot of additional costs related to necessary investments, information gathering, learning a new technique and lower yields stemming from errors during the learning process. At the same time that yields decline due to the organic production characteristics, the farmer cannot sell the product for the organic price premium. This period will have substantial negative impact on farm income and the conversion period is identified as a major barrier in a number of studies, see Acs et al (2007b) and Kerselaers et al. (2007) among others. The time aspect will matter when assessing the potential net income of organic farming as the negative impact from the conversion period on average farm income will decrease with a longer time horizon.

Although reasons other than economic may play a role in the decision to convert, the economic aspect is a common theme in a majority of the reviewed studies and seems to have grown in importance. From summarizing available literature the most important factors working as barriers to convert to organic farming methods seem to be concerns about:

- Yield risk stemming from the adoption of new management routines and production techniques, new crop types and rotation schemes. The restricted use of fertilizers and pesticides decrease the potential yield. The perceived problem of weed and pest, that potentially could destroy the whole harvest, seems to be a major barrier for conversion.
- Price risk due to the still relatively undeveloped market for organic products. Even small changes in supply and demand could have large effects on prices.
- Institutional risk regarded as political uncertainty affecting regulations and subsidies to organic farming. The regulations, or rather the *changes* in the regulations, seem to be a major concern, especially in animal husbandry (Flaten et al. 2010). The financial support payments are supposed to compensate for lower yields and an uncertain market. Due to frequent changes in the level of support and the conditions surrounding the payments, the support itself could be regarded as a risk factor (Acs et al. 2009, Flaten et al. 2010).

3.2 Farm income and risk

A profit maximizing farmer will find the production level where the marginal cost equals the marginal revenue for the good. If the farmer is not compensated for the extra costs of organic farming methods by a sufficient price premium and/or a subsidy, a rational farmer would not convert. The conversion decision could be defined as a decision between the expected value of the alternatives over a certain period. This is of course *conditioned on certain outcomes* each year for the alternatives.

Certain outcomes are rare in reality. Farming in general is by many regarded as a risky business not only depending on the market demand but also on factors harder to deal with such as weather conditions, weed and pests (Hardaker et al. 2004). Taking the farmers decision to convert or not a step further from profit maximization under certainty, the objective then becomes to maximize the utility under uncertain outcomes. Hardaker et al. (2004 pp 34-36) argue that probabilities are subjective for each individual and that the same individual follows some principles (axioms) during decision making and assigns an individually determined utility value to any risky prospect. This also implies that the subjective expected utility (SEU) of a risky prospect is equal to the utility of that prospect if payoffs are weighted according to subjective probabilities.

In the context of decisionmaking, different individuals can be described as risk-neutral, risk-averse or risk-loving (Perman et al. 2003). A risk-neutral individual will chose the alternative with the highest expected payoff no matter what the associated probabilities are. A risk-loving individual will choose the risky alternative if he gets the preferred outcome, even if there is a possibility for an undesired income. A risk-averse individual is prepared to give up some of the expected risky income to receive a lower certain income. The more risk-averse, the more income is the person willing to give up for the certain alternative. Or the other way around, the more risk-averse, the higher compensation or risk premium is necessary for choosing the risky alternative.

Following Perman et al. (2003), the decision problem can be illustrated by Figure 1. The expected utility is a linear combination of the utility from net income Y_1 and Y_2. For a risk-averse farmer, the expected utility E(U) is always less than the utility from an expected income U(E(Y)). Hence a risk-neutral person would choose the point E while the risk-averse person will chose point D, corresponding to the certainty equivalent (CE). The difference of (Y**-Y*) is the risk premium RP. From this follows that the expected utility E(U) equals the utility of certainty equivalent U(CE). This in turn equals the utility of expected income adjusted for the risk premium U[E(Y)- (Y**-Y*)]. This could be summarized as:

$$E(U)= U(CE)= U[E(Y)- (Y^{**}-Y^{*})] \qquad (1)$$

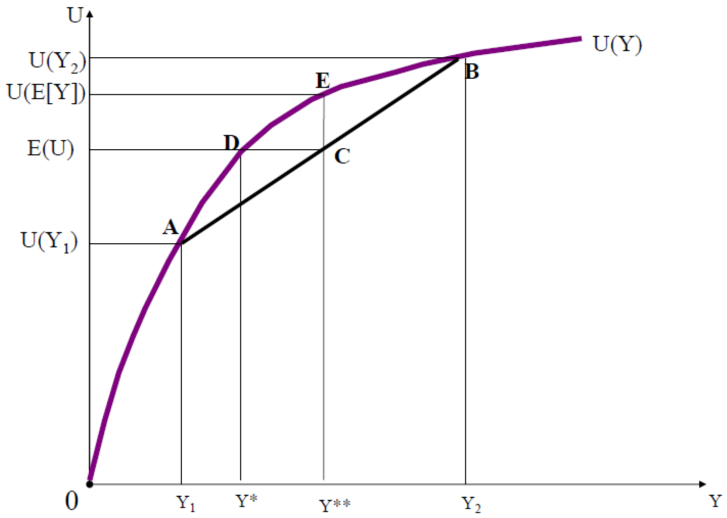

Figure 1. Illustration of decision making under risk. Modified from Perman et al. (2003 p.447)

Perhaps more straightforward, Hardaker et al. (2004 p.114) describe the risk premium as a measure of the cost of the combined effects of risk and risk aversion:

$$RP=EMV-CE \qquad (2)$$

Where EMV is expected monetary value and CE is certainty equivalent. A positive RP implies risk aversion, a negative RP implies risk preference and if RP =0 it implies risk indifference. However, there is often a need to quantify the degree of risk aversion or as illustrated in Figure 1, the curvature of the utility function. As discussed in Hardaker et al. (2004 pp. 100-103), the utility function is defined only up to a linear positive transformation and the measure needs to be constant for such a transformation. The simplest measure of risk aversion that is constant for a positive linear transformation is *the absolute risk aversion function.* Let *w* denote wealth, the curvature (second derivative) of the utility function $U''(w)$ is normalized by the first derivative of the utility function $U'(w)$:

$$r_a\,(w) = -\,U''(w)/U'\,(w) \qquad (3)$$

The relative risk aversion function is a function of income. To get a measure not dependent on a specific monetary unit the *relative risk aversion function* $r_r(w)$, is often used defined as:

$$r_r\,(w) = w r_a(w) \qquad (4)$$

A classification of degree of risk aversion based on the relative risk aversion parameter was made by (Anderson and Dillon 1992):

$r_r\ (w)$=0.5, hardly risk-averse at all;
$r_r\ (w)$=1.0, somewhat risk-averse (normal);
$r_r\ (w)$=2.0, rather risk-averse;
$r_r\ (w)$=3.0, very risk-averse;
$r_r\ (w)$=4.0, extremely risk-averse.

The degree of risk aversion will affect the magnitude of the risk premium and have an impact on the expected utility or certainty equivalent. The approximate risk premium is then given by (Hardaker et al. 2004 p. 114):

$$RP = E - CE = 0.5r_a V \quad (5)$$

Where *E* is expected monetary outcome and *V* is the variance of payoff.

3.2.1 The expected Value-Variance analysis

The mean variance or expected value- variance (EV) analysis is a case of the subjective expected utility case that builds on a series of Taylor series expansions of the utility function further described in Hardaker et al. (2004, pp. 142-143). This implies that the utility of net returns can be defined as a function of mean, variance and higher moments of expected utility. Based on that, *the decision maker will choose the alternative with the highest expected return given risk level or the lowest risk given expected income.* This approach is widely used to make decisions about risky prospects like a financial investment portfolio or a farm plan (Elton and Gruber 1995, Hardaker et al. 2004) The mean and variance of any mix of possible assets *i* is given by (Hardaker 2004, p 145):

$$E = \sum_i x_i e_i \ and \ V = \sum_i \sum_j \sigma_{ij} x_i x_j \quad (6)$$

Where E is expected value of the portfolio, e_i is expected return from asset *i* and σ_{ij} is the covariance of returns from assets *i* and *j* (variance when *i=j*). From a feasible set of assets, the most efficient mix with respect to return, variance and covariance gives an efficient frontier. A crucial factor for the overall portfolio risk is the covariance or in standardized terms, *the correlation*[2] between the different assets (Elton and Gruber 1995). The correlation between the assets will determine the possibility of risk diversification of the portfolio return. Assuming a portfolio of two assets (a) and (b), a negative correlation between the returns of these assets means that when the return of (a) is positive, the return of (b) is negative. If the correlation between asset (a) and (b) is positive, the returns are either positive for both assets or negative for both assets. The total portfolio return will then vary less if the assets are negatively correlated, thus implying a lower risk, everything equal.

[2] Dividing the covariance between two assets by the product of the standard deviation of these two assets produces a variable with the same properties as the covariance but with a range of -1 to +1. This measure is called the correlation coefficient. If σ_{ij} is the covariance of returns of asset *i* and *j*, σ_i and σ_j is the standard deviation of returns of assets *i* and *j* respectively, the correlation coefficient ρ_{ij} is defined as $\rho_{ij} = \sigma_{ij}/\sigma_i\sigma_j$

Which specific point on the frontier or allocation of assets the individual chooses depends on the individual's utility and its degree of risk aversion.

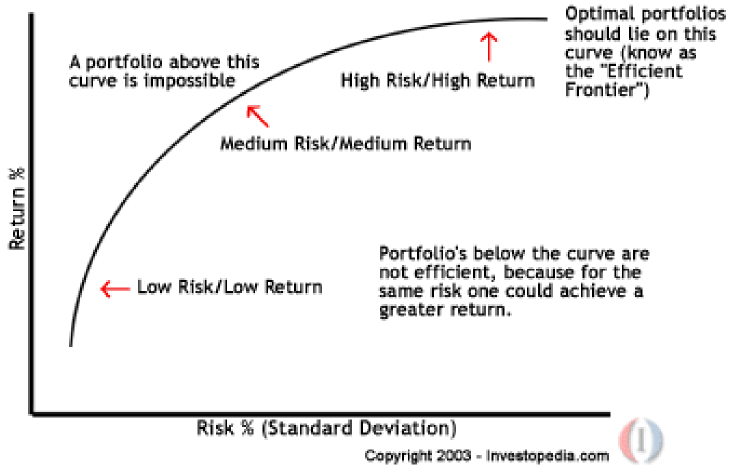

Figure 2. The Efficient Frontier.(www, Investopedia, 2011)

The conditions for the EV analysis to be valid are that the individual always prefers more to less and is not risk-preferring. The conditions also require an outcome distribution that is normal or a quadratic utility function implying that risk aversion increases with the level of payoff (Hardaker et al. 2004). Even though the authors argue that these conditions are unacceptable, they still believe that the EV analysis could be used as an approximation. This would get some support from a study applied on Swedish farm data where the EV model was compared to an empirical moment generating function (EMFG) that is supposed to circumvent the restrictions underlying the EV model (Hedberg 1996). The author concludes that in the context of the study, the EV model gave reasonable approximations of expected utility. However, the EMFG model would be a relevant alternative if the normality of the returns were questionable due to government programs.

3.3 Main sources of income risk in crop production

3.3.1 Yield

From the nature of agriculture, the exposure to weather conditions and surrounding plants and animals poses a great risk to production yield (Hardaker et al. 2004). Selecting the appropriate crop type and rotation for specific geographical characteristics is a way of dealing with risk. In conventional agriculture the use of fertilizers and pesticides has developed from the need to reduce the vulnerability to nature and to ensure higher yields and fewer outbreaks of pests and weeds. In absence of these tools, organic farming is considered to be more risky.

3.3.2 Price

The deregulation of the agricultural market has changed the price setting to be largely dependent on global supply and demand. For the Swedish crop farmer selling to *Lantmännen*[3], there are basically two categories of price contracts; spot/term-price and pool price (www, Lantmännen, 2011):

- The spot/term contracts means that the farmer agrees to deliver the crop at a specified time at a predetermined price. The main difference between the spot and term price is that spot price is for delivery within two months while term price has longer delivery periods. The price for these both types of contracts depends on the current market price that in turn reflects the current international supply and demand. These types of contracts enable the farmer to enter into different contracts, depending on personal beliefs about yield on harvest and international supply and demand. Because they fluctuate with the market, these prices are perceived as more risky than pool prices and require that the farmer keeps updated about market developments.
- Pool price[4] contracts means that the farmer enters a contract agreeing to deliver a certain quantity of the crop to *Lantmännen* when they sell the crop. The price is set once a year for organic crops and twice a year for conventional ones. This is an alternative for a farmer not willing to take additional price risk and who is not monitoring the market.

As in all markets, the crop market is dependent on liquidity. For the most common conventional crops there are international market places where daily transactions develop the actual prices. For organic products the lack of liquidity means that trading is not sufficiently developed as yet. In Sweden approximately half of the conventional farmers are on spot/term contracts while the majority of the organic farmers still stick to pool price contracts (Svantesson 2011). The trend points to more farmers moving to term prices meaning that price fluctuations may play a larger role for the farmer in the future. The deregulated market brings opportunities to take on market risk as well as hedging the risk away.

[3] *Lantmännen* is a national farmer cooperative that is a dominating dealer in the Swedish grain market.
[4] Here, pool price refers to pool 1 prices. For conventional farmers, there is also a pool 2 price dealing with stored crop.

4 Method

This chapter describes the methods used for the empirical application; crop-specific comparative statics, farm net income calculation and the EV model. This is followed by a discussion of the farm assumptions and data collection.

4.1 Empirical application

The analysis assumes a conventional farmer considering converting the farm from conventional to organic production methods. The farmer is assumed to have historical observations of yields, prices and estimated production costs from conventional and organic farms within the same area. The analysis proceeds as follows:

1. The first step is to analyze crop-specific real net returns, yields and real price. The analysis will also look at the relationship between the *variation* of real net returns, yields and price for the different crops. This will give a notion of potential risk and net income of the farms.
2. Second, real net farm income calculations are carried out for 2005-2009 using observed data. The reason to use a five-year period is to reflect the length of the commitment period for a farmer converting to organic methods. A further dimension to the analysis is to use single-year observations instead of average numbers. This would give an indication of the average profitability during the period but also the *variability* of the profits between years. The analysis is carried out for different assumptions to allow for a comparison of the potential impact of the conversion period and the organic support payments.
3. The third and final step is to set up the EV model allowing for a comparison between the *risk adjusted* real net income between the organic and conventional farm. Within the EV framework the efficient frontiers for the different alternatives are derived to get a notion of the risk adjusted real net returns feasible for different crop allocations. Then, the EV model is used to evaluate the different risk premiums for the organic and conventional farm for different grades of risk aversion.

4.1.1 Comparative statics

To identify the sources of risk the data is examined using the coefficient of variation (CV) values. This is measured as the standard deviation divided by the mean and enables the comparison of data with different magnitudes. A higher standard deviation in relation to the mean results in a higher CV value, thus implying higher risk.

4.1.2 Farm real net income calculation

Farm real net income for the hypothetical organic and conventional farms is calculated on a yearly basis.

The yearly *organic* farm real net income E_{org} is calculated as as the sum of the real net returns from each organic crop given the crop allocation:

$$E_{org} = \sum_{i=1}^{N} x_i \times (e_i + s_i) \tag{7}$$

where e_i is the expected real net return from the organic crop i, and x_i is the amount of land allocated to the organic crop i. The organic support payment for each organic crop s_i is the per hectare organic support payment for each organic crop. The expected real net return e_i is estimated as the real price and yield minus real production costs for each of the years. The crop allocations are assumed to be constant over the years following the allocation illustrated in Table 1. The hectare support payment s_i follows the actual levels the corresponding years; 1300 SEK/ha for winterwheat, springbarley, oats and peas, 2200 SEK/ha for rapeseed and white clover seed (Clarin et al. 2010). Ley for fodder is eligibile for support of 500 SEK/ha up until 2006 but this was then taken away in 2007.

The yearly conventional farm real net income E_{conv} is calculated as the sum of the real net returns from each conventional crop given the crop allocation:

$$E_{conv} = \sum_{\mathrm{i}=1}^{\mathrm{N}} x_{\mathrm{i}} \times (e_i) \tag{8}$$

where e_i is the expected real net return from the conventional crop i, and x_i is the amount of land allocated to the conventional crop i.

The different assumptions for the hypothetical farms are:

a) An organic farm with no organic support payments (where s_i*=0)* and no conversion period. This assumption indicates the potential competitiveness of the organic farm compared to the conventional farm based on the organic price premium.
b) An organic farm with no organic support payment (where s_i*=0)* accounting for a mandatory two year conversion period during 2005 and 2006. This assumption indicates the potential impact on the organic farm net income from the conversion period when the farmer is subject to organic crop yields and conventional prices.
c) An organic farm with the inclusion of the organic support payment (where s_i=500, 1300 or 2200 depending on the crop) and accounting for a two year conversion period. This would be the most authentic case reflecting the actual situation a farmer meets when converting the farm from conventional to organic.
d) A conventional farm.

4.1.3 EV model specification

This analysis assumes that the farmer considering conversion is driven by economic motives. Further, it is assumed that the farmer wants to maximize the expected utility that is a function of expected farm real net income *E*:

$$E = \sum_{j=1}^{N} x_i e_i \qquad (9)$$

Where e_i is the expected real net return from crop i, and x_i is the amount of land allocated to crop i.

Recalling eq (6) in chapter 3.2.1, the different set of optimal farm plans lying on the EV efficient frontier is derived by minimizing the variance of real net returns over a feasible set of expected real net incomes:

$$Min\ V = \sum_{i=1}^{N} \sum_{j=1}^{N} \sigma_{ij} x_i x_j \qquad (10)$$

Subject to:
$E = \sum_{i=1}^{N} x_i e_i$
$Ax \leq b\ and\ x \geq 0$,

where expected farm real net income *E* varies over a feasible range, σ_{ij} is the variance covariance matrix of real net returns from the different crops e_i , A is an $M\times N$ matrix of technical restrictions and b is an $M\times 1$ vector of resource stocks.

From the relationship in eq (5) in chapter 3.2.1, the EV model maximizes the expected utility, or similar, the certaint equivalent CE, conditioned on risk aversion and variations of real net returns:

$$E(U(E)) = E - 0.5 r_a * Var(E) \qquad (11)$$

The farmer's decision problem accounting for different degree of risk aversion is set up as:

$$Max\ E(U(E)) = \sum_{i=1}^{N} e_i x_i - 0.5 r_a \sum_{i=1}^{N} \sum_{j=1}^{N} \sigma_{ij} x_i x_j \qquad (12)$$

Subject to:
$Ax \leq b\ and\ x \geq 0,$

where e_i is the expected real net return from crop i, x_i is amount of land allocated to crop i, 0.5 is a constant, r_a is the absolute risk aversion parameter and σ_{ij} is the variance covariance matrix of real net returns, A and b are the same $M\times N$ matrix of restrictions and vector of resource stocks as in eq (10).

The model results will give an approximation of the subjective expected utility or similarly, the certainty equivalent and the risk premium, given different levels of expected income and risk aversion.

4.3 Data sources

4.3.1 Farm data

A general pattern in the distribution of organic land area in Sweden is that the organic share is lower in areas with a higher potential yield and higher in areas with a lower potential yield (Rosenqvist 2003). The former areas are mainly found in southern Sweden where the farms also tend to be larger and more specialised, mostly on high yield crops. In the northern part where the yield potential is lower due to natural conditions, the share of organic area is higher and also includes livestock to a larger extent. This is illustrated by the fact that the most southern counties (Kalmar, Blekinge, Halland and Skåne) have the lowest share of organic land area while counties further north (Jämtland, Värmland, Gävleborg and Västernorrland) have the largest share (Statistics Sweden 2010). The size of organic land area is largest by far in the region of Västra Götaland, almost three times the county with second largest area, the region of Östergötland.

In an agricultural context Sweden is divided into eight production areas where the four counties with the smallest share of organic farmland are part of production areas 1 and 2 (see Appendix 1 for a map of production areas in Sweden). The difference between potential yield in conventional and organic farming is perceived as higher for these areas than for others which could imply a higher risk and resistance to convert. Recalling the government's 20% target of organic farmland this motivates the selection of these production areas for the empirical analysis.

One obstacle when comparing conventional and organic productions is the scarcity of official statistics for organic yields. Ideally, the analysis should be carried out using real farm data to assess the individual farm risk. For a number of practical reasons the availability of such data is limited. The typical farm is approximated with regard to farm characteristic as size and production to mirror the situation in the selected area. Preferably the area should be as small as possible to reflect the typical farm situation. At the same time, Statistics Sweden requires at least 20 observations to publish the yield statistics for a specific area. Due to the lack of statistics of organic farms in Production Area 1, this analysis will be applied on a typical farm in Production Area 2, Götalands Mellanbygd. This area consists of the forested parts of Skåne and Blekinge and Öland and Gotland. The number of organic farms is higher than in Production Area 1 but also has a lower potential yield.

Farm characteristics such as crop type and restrictions are based on a farm profitability study from the Swedish Board of Agriculture (Cahlin et al. 2008). This is complemented based on discussions with persons at the Swedish Board of Agriculture and the Agriwise data base (Karlsson, 2010, Söderberg, 2010). The selection of crops partly differs between the organic and conventional farmers as illustrated in Table 1. The conventional farmer is growing cereals (winter wheat, spring barley and oats). This is complemented with leguminous plants (peas) and oilplants (spring and winter rapeseed). As the conventional farmer is allowed to use fertilizers and pesticides it allows for a more concentrated allocation toward high margin crops. The organic farmer grows similar cereals and peas as the conventional. In organic farming the restrictions on fertilizers and pesticides alter the selection of crops and require a stricter rotation where cereals must be alternated with crops that enrich the soil with nutrients. In addition to peas, this may include grass for seed as white clover seed, and ley or green manuring.

Table 1. Assumed crop type and rotation

	Organic farm		Conventional farm	
	Ha	Share	Ha	Share
Winter wheat	60	30%	80	40%
Spring barley	20	10%	30	15%
Oats	20	10%	20	10%
Peas	30	15%	30	15%
Rapeseed			40	20%
Lay for fodder	30	15%		
White Clover seed	40	20%		
TOTAL	**200**	**100%**	**200**	**100%**

When carrying out the optimization procedure the assumptions of the typical farm allocations are relaxed. A general assumption is that the total area is utilized meaning restrictions that total land equals 200 hectares. Additional restrictions imposed are:

- The conventional farm may choose among winter wheat, spring barley, oats, peas spring and winter rapeseed. The restrictions imposed are a maximum allocation of winter wheat of 50%, max 20% of rapeseed and max 20% of peas.
- The organic farm may choose among winter wheat, spring barley, oats, peas, ley/ensilage and white clover seed. The crop rotations are stricter for organic farms than conventional farms to enrich the soil with nutritients via crops richer in nitrogen. Therefore wheat, barley and oats have to be alternated with peas, ley/ensilage and white clover seed. The farmer can choose the crop-specific rotation within this restriction. Additional restrictions are a maximum allocation to wheat, barley and oats of 40% each, a minimum allocation to ley and white clover seed of 10% each, maximum white clover seed of 30% and maximum peas 20%.
- The organic farm with support is eligible for a risk-free area support depending on crop type. The support levels are set to 2010 years levels; 1450 SEK/ha for wheat, barley, oats and peas, 2200 SEK/ha for white clover seed and 350 SEK/ha for ley.

4.3.2 Farm real income data

The yield data for all crops except cloverseed is collected from yearly reports of production of organic and non organic farming published by Statistics Sweden, (JO 16 SM 2004-2010). The yield is specified for Production Area 2, Götalands mellanbygd. The 2009 yield observation for organic peas is missing due to an insufficient number of reporting farms. To get an approximation, the average coefficient of organic as a share of conventional is calculated for 2003-2008. The yield for 2009 is then estimated from the conventional yield using this coefficient. The yield for cloverseed is collected from official statistics published by the Swedish Rapeseed Assocation, an association promoting the growth of cultivation of oil plants and grass for seed (www, Swedish Rapeseed Association, 2011). The yield numbers are specific for southern Sweden, reported voluntarily by farmers in the area. The yield observation for organic white clover seed is missing for 2003 and is estimated from the conventional yield using the average coefficient of organic as a share of conventional for 2004-2009 (as described above).

Comparable price data for conventional and organic products 2005-2008 and organic prices for the period of 1999-2008 is published by Organic Farmers Cooperation (Ekologiska Lantbrukarna) based on price data from *Lantmännen*. The documents are available on their webpage (www, Organic Farmers Cooperation, 2011). In addition, organic prices have been received directly from *Lantmännen* up until 2010 and enabled the validation of the published prices (Svantesson 2011). The conventional prices for 2003, 2004 and 2009 are collected from the Agriwise farm planning system, with prices originating from *Lantmännen* (www, Agriwise, 2011). Due to data availability, prices for barley, oat and peas are represented by the price category for fodder. The fodder prices are generally lower than for the equivalent crops used in the human food sector. Price data for cloverseed is received from the Swedish Rapeseed Association where organic prices are missing for the years 2003 and 2004. These prices are estimated as the the conventional price plus the average organic price premium for 2005-2009. The 2009 price of organic silage for fodder is collected from a farm planning sheet available at the County of Administrative in Västra Götaland (www, County of Administrative in Västra Götaland, 2011). The price development is assumed to follow the index category of *forage plant* (Foderväxt) in output price index, A-index (www, Swedish Board of Agriculture, 2011). All prices are real prices deflated with consumer price index (www, Statistics Sweden, 2011).

The farm real net income is estimated as (yield/ha) times (price/kg) minus the variable real production costs for each crop. Except for the support payment directed to organic farming, all other types of support are disregarded. This may affect the level of farm net income as well as the impact of crop risk on the total farm income. As the focus of this analysis is to compare conventional and organic farms this should not have a major impact on the results. There are no support payments eligible only to conventional farmers excluding organic farmers. The specific farm support (*Gårdsstödet*) for example, is based on farm size and differentiated by geographical location but the same for the organic and conventional farm (Söderberg 2011).

Figures illustrating yield and nominal price data are found in Appendix 2.

4.3.3 Real production cost estimations

The *short term variable real production cost* includes costs for inputs such as seed, fertilizers and pesticides, fuel for harvesting and transporting the crop. Other production costs are related to services as drying the crop and administrative fees. In reality the quantity of input for each type of crop is rather unchanged over the years. The yield is unknown until harvest and cost is highly dependent on prices on inputs and fuel. When using Agriwise farm planning system the yield is generally based on a rather constant norm value and the cost estimation is sensitive to yield levels. An observation that deviates from the norm has effects on the estimated production costs while at the same time the estimation should be an approximation of the actual cost. The approach used is to estimate the *level* of cost using 2009 year prices and the average yield for 2003-2009.
Agriwise farm planning system lacks data for organic grass for seed. The production cost for white clover seed (including red clover seed and timothty seed in the sensitivity analysis) is estimated using farm planning sheets from the Swedish Board of Agriculture (www, Swedish Board of Agriculture, 2011).

The estimated production costs represent 2009 year levels. To get the development in cost during the period an index is created from selected categories in Agricultural Input Price Index, PM-index (www, Statistics Sweden, 2011). The categories used are “Seed”, “Fertilizers and soil improvers”, “Plant protection products and pesticides”, “Energy and lubricants” and “Other goods and services”. Based on the relative weights of different inputs in the cost estimations an index is created for each crop. For the organic crops the Fertilizers and Pesticides are omitted from the index. To get the costs in real terms, the indices for production costs are deflated with consumer price index.

The estimated real production costs represent the short term variable cost as defined above. Fixed costs as investments together with interest rate payments and maintenance costs for machines are not included. The main argument for that is the trade off between complexity and relevance for the analysis. Previous investments in land, buildings and machines as well as the need for new investments in case of conversion, will vary significantly between farms. This makes general assumptions of these costs difficult and may add uncertainty to the estimates of farm real net income. One example is the practice of machine pools where farmers pay a rent for using the machines instead of making a private investment (Karlsson, 2011). This study relies on public data and the short term real variable costs are judged to reflect the actual costs for a majority of the farms. To add other types of costs in this analytical framework is judged to add more uncertainty than it would benefit the analysis.

Labor costs are also left out in the analysis. The argument for this is again the trade off between complexity and relevance of the analysis. Increased labor demand associated with extra costs for the farm is sometimes brought up as a concern for the conversion decision (Acs et al. 2007b, Lampkin and Padel 1994). In Sweden, the view expressed by the Swedish Board of Agriculture is that the difference for labor demand for organic and conventional crops is very small in general (www, Swedish Board of Agriculture, 2011). The potentially extra workload for dealing with weed for example is compensated by not using labor for the usage of fertilizers and pesticides. The required work load per hour will also depend on the size of the farm. Due to the relevance of labor cost as a potential barrier of conversion in other studies, these are accounted for in a sensitivity analysis in chapter 5.6.1.

5 The empirical results

This chapter will present the results from the data analysis. It will start with the compararative statics of the crop-specific data that will also analyse the relationship between the different crops. This is followed by the farm net income calculations comparing the profitability of a typical organic and conventional farm. Finally EV results are presented by deriving the efficient frontier and maximizing utility for different risk aversion parameters. The chapter ends with a sensitivity analysis of the results.

5.1 Comparative statics results

To identify the sources of risk, historical data is examined using the *coefficient of variation*, CV value. A comparison of real net returns, yield and price with regard to levels and risk is relatively straightforward for cereal crops as winter wheat, spring barley and oats when they are commonly used in both organic and conventional farming. This is also true for peas. For crop farms in southern Sweden, rapeseed is typical for the conventional farm while white clover seed and lay are typical for the organic farm. Different crops are not directly comparable. These results will rather indicate the risk return characteristics for available crops for the organic and conventional farm respectively, hence potential impact on farm risk and income level.

The organic support payment is excluded from the price and real net return comparison as not to bias the risk results and to give an indication of the magnitude of the organic price premium.

In organic and conventional crops are compared with regard to net returns and risk Based on the results, the average real net return is higher for organic spring barley, oats and peas than the conventional equivalents. The result for winter wheat differs from the general result, as the real net return is lower for organic winter wheat than conventional. The risk in real net returns is higher for the conventional crops than the organic equivalents. Lay and white clover seed are not directly comparable with spring and winter rapeseed but white clover seed has the highest real net return by far of the four. The risk is highest for spring rapeseed with a rather low real net return.

*Table 2. Average real net returns and CV-values 2003-2009**

		Real net return (SEK/ha)					
Organic		Winter wheat	Spring barley	Oats	Peas	Ley	White clover seed
	Mean	3278	2785	2203	1543	1178	3259
	CV	0.61	0.53	0.80	0.74	0.45	0.89
Conventional		Winter Wheat	Spring barley	Oats	Peas	Spring rapeseed	Winter rapeseed
	Mean	3591	1621	1367	472	1214	2792
	CV	0.90	0.88	0.88	2.32	0.99	0.67

*For the comparable crops such as winter wheat, spring barley, oats and peas, the crop with the higher risk or higher mean is underlined.

Disaggregating the real net returns into yields and real prices give opposed results with regard to risk as illustrated in Table 3 and in Table 4 respectively.

The *yield risk is higher for the organic comparable crops* although the difference between organic and conventional is small for wheat and barley. The yield risk for white clover seed is substantially higher than for the other crops while the yield risk for lay is lower. The yield risk for spring rapeseed as well as winter rapeseed is similar to the risk for conventional cereal crops. Yield levels are substantially lower for the comparable organic crops than the conventional.

The *price risk is higher for the organic comparable crops*, except for winter wheat where the risk is higher for the conventional. The price risk is also higher for for conventional rapeseed than organic ley and white clover seed. The price levels are higher for all comparable organic crops than the conventional.

*Table 3. Average yield and CV-value 2003-2009**

		Yield (kg/ha)					
Organic		Winter wheat	Spring barley	Oats	Peas	Ley	White clover seed
	Mean	3099	2700	2627	1895	2886	149
	CV	<u>0.14</u>	<u>0.14</u>	<u>0.25</u>	<u>0.30</u>	0.13	0.41
Conventional		Winter wheat	Spring barley	Oats	Peas	Spring rapeseed	Winter rapeseed
	Mean	<u>6193</u>	<u>4261</u>	<u>4081</u>	<u>3157</u>	1824	3184
	CV	0.13	0.13	0.18	0.16	0.15	0.10

*For the comparable crops such as winter wheat, spring barley, oats and peas, the crop with the higher risk or higher mean is underlined.

*Table 4. Average real price and CV-value 2003-2009**

		Real price/kg					
Organic		Winter wheat	Spring barley	Oats	Peas	Lay	White clover seed
	Mean	<u>1.95</u>	<u>1.90</u>	<u>1.73</u>	<u>2.41</u>	1.19	54.35
	CV	0.35	<u>0.38</u>	<u>0.43</u>	<u>0.34</u>	0.12	0.23
Conventional		Winter wheat	Spring barley	Oats	Peas	Rapeseed**	
	Mean	1.30	1.11	1.04	1.35	2.52	
	CV	<u>0.37</u>	0.32	0.31	0.29	0.26	

*For the comparable crops such as winter wheat, spring barley, oats and peas, the crop with the higher risk or higher mean is underlined.
**The price for spring and winter rapeseed is the same

According to data, the yield is lower for comparable crops while the organic price is higher, confirming an organic price premium. In Table 5, the average organic price premium and the average organic yield as a share of average conventional yield is illustrated for the comparable grain crops. Based on the results, the organic price premium compensate for the lower yield levels if production costs are disregarded.
The correlation coefficient between yield and price for the comparable crops is illustrated in Table 6. The results indicate a stronger negative correlation between yield and price for organic crops than conventional. A negative correlation means opposed movements, when

yield decrease, price increase[6]. This could be an explanation to why the aggregated risk in net return decreases to a larger extent for the the organic crops than the conventional.

*Table 5. Average organic price premium and average organic yield as share of average conventional yield.**

	Winter wheat	**Speing barley**	**Oat**	**Peas**
Organic price premium	50%	72%	67%	78%
Organic yield as share of conventional	50%	63%	64%	60%

*The average is estimated for the period 2003-2009.

Table 6. Yield and real price correlation, 2003-2009

	Correlation coefficient					
Organic	Winter Wheat	Spring barley	Oats	Peas	Lay	White Clover seed
	-0.14	-0.58	-0.49	-0.49	-0.20	-0.56
Conventional	Winter Wheat	Spring barley	Oats	Peas	Spring rapeseed	Winter Rapeseed
	0.20	-0.30	-0.52	-0.09	0.08	0.05

As discussed in chapter 3.2.1, the correlation between the real net returns of the different crops will affect the overall risk in farm real net income. Everything else equal, a negative correlation between the real net return of the different crops will decrease the risk in farm real net income. The correlation between the crops will affect the crop allocation when optimizing the risk return relationship in the EV model. The correlation coefficients between the the real net returns for the different crops are illustrated in Table 7 for the organic farm and in Table 8 for the conventional farm.

The real net returns of the organic crops are positively correlated with the exception of white clover seed that is negatively correlated with all the other organic crops. For the conventional crops, the real net returns are positively correlated for all the crops. This will affect the possibilities of risk diversification as the real net returns for all the conventional crops moves in a similar way. This implies a feasible set of crops that enables a larger degree of risk diversification for the organic farm than the conventional farm, everything else equal.

[6] A correlation coefficient of -1 implies opposite movement of the same magnitude while a coefficient of +1 implies the same movement of the same magnitude. A correlation coefficient of zero implies no correlation at all.

Table 7. Correlation coefficients between the real net returns of organic crops during 2003-2009.

	Winter wheat	Spring barley	Oats	Peas	Lay	White clover seed
Winter wheat	1.00					
Spring barley	0.86	1.00				
Oats	0.92	0.89	1.00			
Peas	0.58	0.43	0.59	1.00		
Lay	0.47	0.80	0.69	0.13	1.00	
White clover seed	-0.24	-0.56	-0.30	-0.18	-0.41	1.00

Table 8. Correlation coefficients between the real net returns for conventional crops during 2003-2009.

	Winter wheat	Spring barley	Oats	Peas	Spring rapeseed	Winter rapeseed
Winter wheat	1.00					
Spring barley	0.86	1.00				
Oats	0.69	0.92	1.00			
Peas	0.93	0.87	0.64	1.00		
Spring rapeseed	0.89	0.65	0.43	0.89	1.00	
Winter rapeseed	0.75	0.33	0.06	0.66	0.82	1.00

The general results suggest:

- Real net returns are higher and less risky in general for the organic crops than the conventional ones.
- When disaggregating data to yield and price, the risk is higher in general for the organic comparable crops.
- The organic price premium compensates for lower yield levels in organic comparable crops, disregarding the production costs.
- The organic yield/price relationship shows a stronger negative correlation for organic crops.
- The correlations between the real net returns for the different crops are positive in general for the organic crops as well as the conventional crops.
- The exception is the negative correlation between the real net returns of white clover seeds and the other organic crops. Everything equal, this implies a feasible set of crops that enables a potentially lower farm income risk.

5.4 Farm real net income calculation results

The farm real net income calculations for a five year commitment period of 2005-2009 based on different assumptions is illustrated in Table 9. The first column (a) represents the result of the hypothetical organic farm without organic support. The second column (b) represents the hypothetical farm without organic support that needs to undergo a conversion period during 2005 and 2006 meeting organic yield and conventional prices. The third column (c) represents the most authentic situation for a farmer considering conversion facing the conversion period (2005 and 2006) but is eligible for organic support payments during the entire period. The fourth column represents the organic support payments that decreased in 2007 due to the omitted support for lay. The fifth column (d) represents the conventional farm.

Assuming no conversion period and no organic support payments (assumption (a) first column), the result show a marginally lower net income but a substantially lower income risk for the organic than the conventional farm.

Assuming conversion during 2005 and 2006 (assumption (b) in the second column) decreases the average net income and increases the income risk substantially. The difference in net income from the situation of no conversion, is around 400 000 SEK for each of the conversion years. This changes the *average* income from approximately 548 433 SEK to 386 666 SEK, a difference of approximately 162 000 SEK.

Assuming the most authentic situation where the farm converting to organic is eligible to support payments (assumption (c) in the third column) results in a substantially higher real net income and a substantially lower risk compared to the conventional farm. Because the support levels are nearly constant during the period this gives a standard deviation near zero. Adding the support per hectare to crop return per hectare increases the level of income. This will be reflected in a lower CVvalue, hence a lower risk.

Extending the sample period to 2003-2009 alters some of the results as illustrated in Table 10. The average real net income is marginally higher for the organic farm assuming no conversion and no support than the conventional. The risk is still lower for the organic farm. When including the support the results are unchanged compared to sample period 2005-2009. The net income is substantially higher and the risk is substantially lower for the organic than the conventional farm.

Table 9. Farm real net income calculation of a typical organic and conventional farm 2005-2009.*

Year	Organic farm				Conventional farm
	Assumtion (a) No support No conversion	**Assumtion (b) No support Conversion***	**Assumption (c) W Support Conversion****	**Organic Support payment**	**Assumption (d)**
2005	517 651	80 768	352 768	272 000	248 514
2006	309 081	-67 870	204 130	272 000	166 485
2007	698 222	698 222	955 222	257 000	1 218 324
2008	847 635	847 635	1 104 635	257 000	879 458
2009	369 574	369 574	626 574	257 000	313 857
Mean	**548 433**	**385 666**	**648 666**	**263 000**	**565 328**
CV	**0.37**	**0.91**	**0.53**	**0.03**	**0.73**

*Crop type and rotation based on Table 1

**Conversion during 2005 and 2006 with organic yield and conventional prices

*Table 10. Average real net income and risk for a typical organic and conventional farm 2003-2009**

	Organic No support Conversion**	Organic W support Conversion**	Conventional
Mean	508 447	774 019	489 141
CV	0.40	0.26	0.82

*Crop type and rotation based on Table 1

**Conversion during 2005 and 2006 with organic yield and conventional prices

The general results suggest that:

- Disregarding the conversion period and the organic support payments, the average real net income for the organic farm is in parity with the average real net income of the conventional farm. The income risk however, is lower for the organic than the conventional farm.
- The conversion period has a substantial negative impact on the average income level as well as the income risk for the organic farm.
- The organic support payment has a substantial positive impact on the average income level as well as the income risk for the organic farm.
- Assuming conversion and organic support, the organic farm has a higher real net income and a lower income risk than the conventional farm.

5.5 Expected Value Variance (EV) results

First the efficient frontier is derived by minimizing the risk given different levels of expected real net incomes. These results reveal the potential combinations of crops that give the highest expected risk adjusted returns for the organic and conventional farm. This is followed by the results from the expected value variance (EV) analysis where expected utility is maximized for different levels of risk aversion parameters.

5.5.1 The Efficient Frontier

As illustrated in Figure 3, the efficient frontier for the organic farm without support is situated on a higher level than for the conventional farm. This means that for a given level of income, the risk will be lower for the organic farm, or the other way around, for a given level of risk, the organic farm will have a higher expected income. This result is probably due to both crop-specific risk return characteristics and the correlation between the feasible det of crops. As illustrated in Table 7, the negative correlation between the real net return of white clover seed and the other crops, benefits the potential risk diversification of the organic farm. The distance between the organic and conventional efficient frontier increases with a higher expected income. This could be due to the crop-specific characteristics but also to imposed restrictions.

Imposed restrictions of total land utilization combined with restrictions on crop allocation and rotation limits the feasible set of combinations representing the efficient frontier. The empirical efficient frontiers will thus deviate from the theoretical one illustrated in Figure 2.

A risk-neutral farmer would be indifferent of the alternatives for a given level of income. Based on the results the maximized potential return is higher for the organic alternative with support included suggesting this to be a superior alternative even if risk-neutral. Based on the results, a risk-averse farmer would always choose the organic alternative. The difference is further enhanced if the organic support is included.

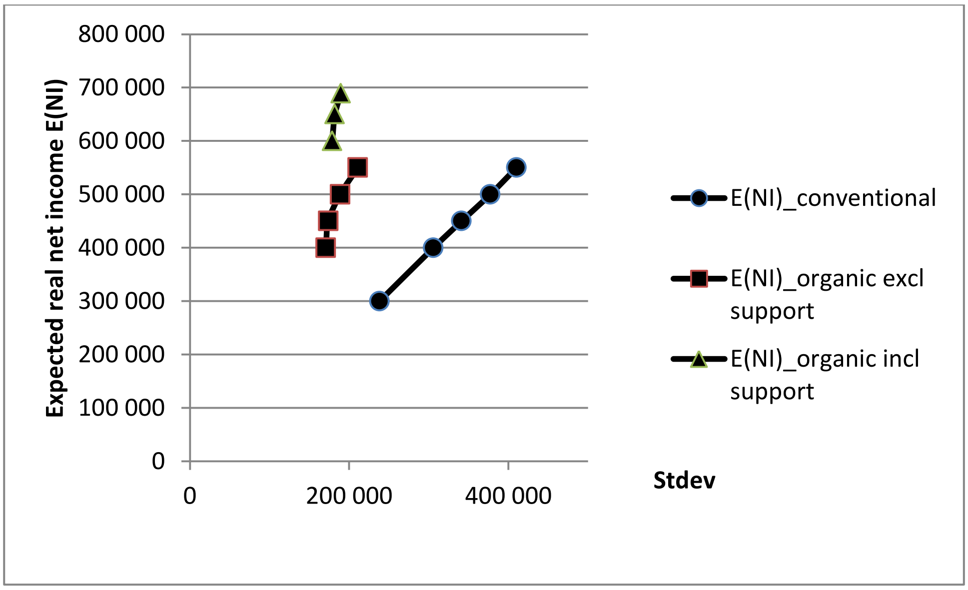

Figure 3. The efficient frontier for the organic and the conventional farm

5.5.2 EV results

The expected utility E(U(E)) is approximated as the expected net income E adjusted for a risk premium RP. The risk premium is an approximation of the price of risk or how much of the expected income the farmer is willing to give up in order to receiving the certainty equivalent, CE. The price of risk or the magnitude of the risk premium will depend on the risk attitude. The risk attitude is approximated by varying the relative risk parameter (RRAP) [7] where the value of *0* implies risk-neutrality, *1* represents “normal” risk aversion and *4* an extremely risk-averse individual. When evaluating different policy scenarios on Swedish farms, (Hedberg 1996) used the relative risk parameters 1 and 2.25 referring to international studies.

The expected net income for the conventional farm based on the typical allocation is set to about 500 000 SEK per year, resembling a yearly income (Söderberg, 2011). The expected utility is maximized for different values of RRAP and the results are illustrated in Table 11.

Assuming a RRAP value of zero implies a risk-neutral farmer. The risk premium is zero as the utility equals expected income and the farmer will be indifferent of the alternatives. When assuming RRAP of 1 and higher implying different degrees of risk aversion, the risk premium per hectare is substantially higher for the conventional than the organic farm. The standard deviation for the conventional farm is substantially larger implying a crop portfolio with a higher overall risk. The magnitude of the risk premium increases with a stronger risk aversion.

The results from repeating the above procedure with a lower expected return, 400 000 SEK, is illustrated in Table 12. The risk premium is still higher for the conventional farmer although the difference is the magnitude of differences is lower than for an expected income of 500 000 SEK. This was expected from the results in the efficient frontier where the distance of the efficient frontiers increases with a higher expected income.

The standard deviation decreases for both farmes when changing the RRAP from zero to 1. This means that the efficient crop allocation changes when the risk is accounted for. The standard deviation is constant and the allocation unchanged when when altering the risk parameter from normal to extreme risk aversion.

Table 11. Expected Value-Variance results based on an expected income of 500 000 SEK

	Conventional			**Organic excluding support**		
RRAP	Std	E(U) Conv	RP/ha	Std	E(U) Conv	RP/ha
0	364 683	500 000	-	179 300	500 000	-
1	345 737	380 466	598	146 519	478 532	107
2	345 737	260 932	1 195	146 519	457 064	215
3	345 737	141 398	1 793	146 519	435 596	322
4	345 737	21 864	2 391	146 519	414 129	429

[7] Where the relative risk parameter $r_r\ (w) = w * r_a(w)$

Table 12. Expected Value-Variance results based on an expected income of 400 000 SEK

	Conventional			Organic excluding support		
RRAP	Std	E(U) Conv	RP/ha	Std	E(U) Conv	RP/ha
0	296 941	400 000	-	167 223	400 000	-
1	252 142	320 531	397	167 223	365 046	175
2	241 061	260 932	695	146 519	330 092	350
3	345 737	161 592	1 192	146 519	295 138	524
4	345 737	82 123	1 589	146 519	260 184	699

The general results suggest that:
- The efficient frontier for the organic farm is situated on a higher level than for the conventional.
- A risk-neutral farmer will always achieve a better risk adjusted return fron the organic alternative.
- The difference is further enhanced when including the organic support.
- The EV results suggest a lower risk premium for the organic farm than the conventional.
- The risk premium increases with a stronger risk aversion

5.6 Sensitivity analysis of the results

5.6.1 Accounting for labor cost

Repeating the analysis but accounting for labor cost does not alter the results in a significant way. The results still indicate that a risk-averse farmer should choose the organic alternative. The labor costs affect the *levels* of net returns for each crop but not the relationships between them. This is of course conditioned on the assumption of small differences between labor demand of conventional and organic crops as expressed by the Swedish Board of Agriculture. As for all estimations, the results are dependent on input data and the labor cost for individual farm may deviate from the estimates.

5.6.2 Accounting for different geographical areas

Repeating the analysis for a different geographical area does not alter the result. The comparative statics illustrated in Table 13 confirm the previous results that the average net return is higher and the risk is lower for the organic comparable crops. However, there are som differences between the areas with regard to the complementing crops that potentially could affect the overall farm income. Based on available yield statistics, red clover seed and timothy seed are more commonly used than whitecloverseed. Organic red clover seed and timothy seed have a lower expected return than organic white clover seed. Also according to statistics, the conventional farmer in Uppsala County only grows spring rapeseed that has a lower expected return than winter rapeseed. When applying the the EV analysis using these data but otherwise the same rotation restrictions, the main results are robust. A rational risk-averse farmer should choose the organic alternative.

*Table 13. Average real net return and coefficient of variation (CV) values 2003-2009, Uppsala County**

Real net returns (SEK/ha)								
Organic		Winter wheat	Spring barley	Oats	Peas	Ley	Red clover seed	Timothy Seed
	Mean	4463	3002	2765	2569	1345	837	110
	CV	0.62	0.70	0.78	0.50	0.19	2.36	25.58
Conventional		Winter wheat	Spring barley	Oats	Peas	Spring rapeseed		
	Mean	3461	1989	1829	1036	1879		
	CV	0.91	0.85	0.94	1.11	0.58		

*For the comparable crops such as winter wheat, spring barley, oats and peas, the crop with the higher risk or higher mean is underlined.

6 Analysis and discussion

Based on the empirical results an important question that arises is if the observed hesitation of Swedish farmers to convert to organic farming could be a result of rational behavior due to the higher level of risk in organic farming and an insufficient risk premium. If this is not supported by the results, what could then be plausible explanations to barriers of conversion? The empirical application addresses the following questions:

- Based on historical data, is organic farming more risky than conventional farming?
- Based on historical risk adjusted returns, should a rational profit maximizing farmer convert to organic farming?

6.1 Is organic farming more risky than conventional?

6.1.1 Based on crop-specific real net returns, organic farming seems less risky than conventional.

The empirical results suggest that the crop- specific real net returns are higher in general and less risky for organic crops than conventional. This is in line with the idea of organic farming as more profitable but contrary to the idea of organic farming as potentially more risky as suggested by Acs et al. (2009) among others.

However, disaggregating the net return into two components, price and yield, results in a lower average yield for organic than conventional crops as expected but also a *higher yield risk.* This confirms the arguments that the restricted use of fertilizers and pesticides decreases the levels of yield as well as increases the risk due to the higher vulnerability to weed and pest damage. This would also support the perception expressed in some several studies (Khaledi et al. 2010, Ferjani et al. 2010) that fear of weeds and insects is an important factor acting as a barrier for conversion. The yield is potentially the most important factor in the conversion decision. The key to success for a farmer converting from conventional to organic will to a great deal depend on individual skill in adapting new management and techniques, where the outcome may vary between “success” and a totally destroyed harvest due to weeds or insect infestation.

Based on the disaggregated results, organic prices are higher but also more risky in general than conventional prices. The higher risk in organic prices supports the argument that a less developed market is more sensitive to changes in supply and demand, leading to a greater fluctuation and uncertainty. The organic price premiums seem to compensate for lower yield levels supporting the results in Nieberg and Offerman (2003) where they suggest that the premium received in organic crop production is an important determinant for farm profitability. On the other hand, the premium/yield comparison does not account for any differences in risk or production costs and may still be regarded as insufficient by individual farmers. This would support the results in Flaten et al. (2010) that too low organic price premiums are one of the main reasons for opting out of organic farming. As opposed to yields, prices are externally determined where the individual farmer has little power to to affect the outcome.

A potential explanation of why the results differ between real net returns and disaggregated price and yield could be the generally stronger negative yield/price relationship for organic than conventional crops. In a competitive market, everything else equal, a lower yield would decrease the supply and if demand were the same, increase the price for the good. This implies a negative yield/price correlation. The higher negative correlation for organic yield/price than the conventional equivalents could be interpreted as the organic market is less developed with prices more sensitive to changes in yield (supply). This could also support arguments in favour of subsidies, in order to assist the market mechanisms. On the other hand, the weaker negative correlations or even positive correlation for some of the conventional crops, indicate a perverse relationship between yield and price, contrary to economic theory. One probable explanation could be the deregulation of the agricultural market where prices on the most common and globalized crops are determined by the international commodity/grain markets and decoupled from the Swedish yield situation. An argument in favour of this explanation would be the result of a positive yield/price correlation for winterwheat and rapeseed. On a global basis these crops are together with soybeans maize and cotton the most traded ones. For crops grown and traded in smaller quantities, the market is more local and prices should reflect the Swedish supply/demand situations to a larger extent, just as indicated by the reults.

As discussed in chapter 3.3.2, the conventional farmer has the option to sell their products on spot/term contracts where prices are quoted daily as opposed to the pool price that is set once a year reflecting the average price. This analysis is based on pool prices and hence does not account for the share of conventional farmers on term/spot contract. This share has increased during the sample period and at present, rougly half of the conventional farmers are using term/spot contracts. The access to term/spot contracts enables the conventional farmer to affect the individual price risk by entering into different contracts depending on their personal beliefs with respect to market developments. Everything else equal, this would imply a greater dispersion in individual farm incomes where some will gain and some will lose, even if the average price does not differ substantially from the pool price. Until the organic market is liquid enough the *individual* organic farmer will lack the opportunity to affect the price to the same extent as the conventional farmer. Leaving out the term/spot contracts in the price risk comparison could then hypothetically lead to an *underestimation of the individual price risk* in conventional farming. However, as the commodity market nowaday is open for everyone[8], any farmer could hypothetically affect farm income by trading on the market and add extra price risk as well as hedge the price risk away regardless of pool or term/spot contract.

Another explanation to the different results of real net returns and disaggregated yield and price could be the production cost per hectare. Based on this analysis, the average cost per hectare is lower and less risky in organic farming, explained by the difference in composition of inputs. As the conventional farms use fertilizers and pesticides showing the largest price fluctuation during the sample period, the cost index for the conventional farm is affected. Hovewer, caution is needed when interpreting the estimated production cost levels. Individual farm costs could differ substantially from these estimations. The general results based on the comparison between different crops should be rather robust though, as the cost estimations are based on the same crop planning system using the same sources (except white clover seed).

[8] In Sweden *Handelsbanken* is the main actor offering different alternatives of grain trading. With the help of internet a larger market is accessable.

Caution is also needed for not confusing production cost *per hectare* with production costs *per kilo* crop. Based on the same data, cost per kg are higher for organic than conventional crops. This would be in line with the general notion of higher production costs for organic products motivating an organic price premium.

6.2 Should a rational farmer convert from conventional farming to organic farming?

The comparative statics results suggest a lower risk for organic farming which is opposite to the perception of organic farming as more risky. A higher risk, however, is obtained when separating yield and price. Potentially disregarded when focusing on crop characteristics, are restrictions associated with organic farming. These restrictions limit the crop selection, allocation and and rotation scheme and affect the risk as well as the income on a farm level.

6.2.1 The farm real net income calculation results suggest lower risk and higher profitability in organic farming

The farm real net income calculations are applied using different assumptions to be able to identify the impact from the conversion period and the organic support payments. The empirical results comparing the organic farm with no support and not accounting for a conversion period give somewhat ambiguous results regarding net income levels, depending on selected time period. This would indicate a sufficient price premium even when real production costs are accounted for and further confirm the importance of the price premium for farm income as argued by Nieberg and Offerman (2003). The income risk is lower for the organic farm, regardless of selected time period. This indicates that the imposed restrictions in this specific study do not add enough risk to offset the generally better organic crop-specific real net return characteristics.

However, assuming a conversion period has a substantial negative impact on average farm net income as well as the risk. Based on the numbers in this analysis, the liquidity loss for each of the conversion years is of the same magnitude as the average yearly income (excluding the support). Even if the farm in reality could have other sources of income the results give an indication of the potential stress on liquidity. It also poin ts out the relevance of time percpective for the conversion decision when the impact on the average income from the conversion period will diminish with a longer time period. The results strongly support the argument stressed in several other studies of the conversion period as strenuous, see e.g (Acs et al. 2007b, Kerselaers et al. 2007, Lampkin and Padel 1994). This would pose a substantial source of risk and a potential barrier for a farmer considering converting.

Based on the results, the economic success of converting to organic farming five years ago would be conditioned on the organic support payments The importance of the organic support is in line with results from Germany (Nieberg and Offermann 2006) as well as results based on farms in several EU countries (Offerman et al. 2009). From a risk perspective the non-risky organic support payment lowers the overall income risk substantially. In really bad years, the support will become a significant source of income while perhaps less important in more profitable years. This also implies that farms with a lower per hectare income benefit more from the support than farms with higher margins. Due to the Swedish geography, the natural conditions vary substantially between different areas. From this point of view it could be argued that organic farmers in southern Sweden, with a higher potential yield, are less supported than the ones in northern Sweden with a lower potential yield.

Conditioned on the organic support payment, the farm real net income results agree with other studies arguing that organic farming is at least as profitable as conventional. The support is a valuable source of certain income and decreases the income risk substantially. However, the dependence of organic support could pose a risk not accounted for in this analysis. The concern of increased vulnerability is expressed by Zander et al. (2008) and further discussed in chapter 6.3.3.

6.2.2 The EV results suggest a lower risk premium in organic farming

Based on risk adjusted farm real net income, the organic alternative is superior to the conventional one assuming a rational risk-averse farmer. These results are robust even when the financial support is excluded. The efficient frontier for the organic farm is situated on a higher level than for the conventional farm. This implies that for a given level of risk, the income will always be higher for the organic farm or the other way around, given an expected net income, the organic farmer will take a lower risk. This would further support that the generally better organic crop net return characteristics is not off-set by the imposed restrictions in this specific study. In this case the imposed rotation restrictions are rather beneficial for the farm income risk when the real net return of white clover seed is negatively correlated with the other organic crops.

The EV results further confirm the organic alternative as superior to the conventional. A risk-neutral farmer would experience the same utility given the expected income regardless of risk. Assuming risk aversion results in a substantially lower risk premium for the organic farmer than the conventional farmer. This is contrary to the perception of a higher risk premium in organic farming and suggests that the hesitation to convert is not a rational behaviour based on an insufficient price premium. These results agree with Kerselaers (2007), arguing that the common perspective revealed in surveys underestimates the economic potential in organic farming and hampers the conversion. However, the conversion period is not accounted for in the EV model and could potentially increase the organic risk premium. Judging from the the farm real net income calculations it should be plausible to believe that this would be compensated for by the organic support if this was included in the EV model.

When moving from risk-neutral (RRAP= 0) to “normally” risk-averse (RRAP= 1) in the EV model, the crop allocation changes from a higher to a lower risk. This would confirm that the individual risk attitude affects the behaviour and choice of risk level. Given an expected income, the risk-averse person would prefer the less risky alternative. When changing the degree of risk aversion the allocation is not affected even if utility decreases implying a higher risk premium. This would be in line with Hedberg (1996) who applied the EV model on Swedish farm data and found that the risk premium is affected but hardly the crop allocations when changing the RRAP from 1 to 2.25. This would suggest that the degree of risk aversion is difficult to categorize in theory as well as in real life but could also be an effect from model assumptions.

If risk-neutral, the farmer would in theory be indifferent to alternatives giving the same expected income. Based on these empirical results, even a risk-neutral farmer would choose the organic alternative conditioned on the organic support as this enables a higher income level than the other alternatives.

If there are no restrictions at all, a maximization of income disregarding risk would lead to an allocation to the crop with the highest net return. Based on data, this means 100% wheat for both the organic and conventional farmer implying a lower net income and a lower risk for the organic farmer than the conventional. Even if this would not be an alternative in reality it puts the results in perspective. Another reservation of the results would be the somewhat unrealistic assumptions of the EV framework. The individual farmer is able to maximise the risk adjusted return by choosing the right combinations with regard to crop-specific variance as well as the correlation with other crops. It is plausible to believe that the the crop type, allocation and rotation restrictions will largely depend on other factors such as the natural conditions on the farm.

6.3 Overestimated /underestimated sources of risk

Based on the empirical results, the rational behavior for a risk-averse rational farmer would be to convert to organic farming. The observed persistence of Swedish crop farmers to convert could imply an overestimation of perceived risk or the presence of actual risk factors that is underestimated or disregarded by this empirical analysis.

6.3.1 Focus on yield and price exaggerates the perceived risk

As suggested by Koesling et al. (2004) and others, farmers put yield and price as the top rated source of risk. As prices are determined externally, what is left for the farmer to influence is the yield. As the organic farmer can not rely on fertilizers and pesticiedes the dependency of the individual skill would be even greater than in conventional farming. With a daily exposure to factors affecting the yield, it would hardly be surprising if the yield risk would get a disproportional weight for the decision to convert. The fear of weed and insects is confirmed as a major barrier of conversion in several studies e.g Khaledi et al. (2010), Flaten et al. (2010) and Ferjani et al. (2010). Also discouraging may be the insight that the yield success or disaster will largely depend on the individual ability to adapt new practices.

Observing official statistics of yield and price may be further discouraging by confirming the common perspective of organic farming as more risky. This suggests the need of farm specific advice to put numbers in perspective and to provide knowledge of organic practises.

6.3.3 The learning curve during the conversion underestimates the actual risk

The “actual” conversion period may in reality stretch further than the regulated two years. Even if the farmer can sell the products with the organic price premium after two years, the yield levels may still suffer. Adapting to organic methods may well take longer than two years and the learning curve and risk may be underestimated.The first years may be characterized by trial and error and for natural reasons it takes time to correct mistakes. The concern of the extended conversion period is acknowledged in some countries having support schemes with conversion compensation stretching longer than two years, for example Denmark and France (Schwarz 2010).

The learning curve is directly related to the potential yield. Hypothetically, this would lead to an improved yield statistics, given that no new farms were included. Access to external sources of expertise would be a way to shorten the learning curve and mitigate potential negative effects from the conversion. This may be problematic due to the insufficient number of experts in organic farming or at least unevenly distributed within the country (Cahlin et al. 2008). Also an expressed concern is that the advisors are usually experts within conventional or organic farming methods, meaning that a farmer considering conversion may have to change advisor which may be a further barrier depending on the relation.

6.3.4 Institutional risk is hard to quantify, underestimates the actual risk

As other studies suggest, political risk affecting regulations and subsidies, is an important barrier of conversion. As Sweden is part of EU and the Common Agricultutal Policy CAP, the risk will, to some extent, depend on international politics.

Potentially underestimated by the empirical results is the risk stemming from the restrictions in organic farming. The conventional farmer has larger degrees of freedom to concentrate on the crops with higher margins than the organic farmer. This could in reality have a larger impact on the perceived risk as well as the actual risk than reflected in this empirical analysis.

The commitment period for the eligibility to organic financial support is five years. If the farmer fails to fulfill the regulations at any time of the period, the support would be cut off partly or totally (www, Swedish Board of Agriculture, 2011). Conflicts between the certification authority and the farmer regarding regulation fulfillments could postpone the support payment until the conflict is resolved. This gives a lot of power to the personel at the certification authority and poses a great risk to the individual farmer. The importance of regulations as a barrier of conversion is supported by Flaten et al. (2010) among others. Further confirming this is result from Khaledi et al. (2010) putting forward the complication of the process to become an organic producer as an important barrier.

The organic support payment could itself be regarded as a potential risk factor. The farm net income results indicate the importance of the support payment for farm risk as well as income. A concern that a high dependability increases vulnerability to political decisions is expressed by Zander et al. (2008). During the present Rural Development Program (RDP) 2007-2013, the support scheme has changed twice. The new RDP starting in 2014 could lead to further changes in conditions and support levels suggesting that the political risk should not be disregarded as as a barrier for conversion. As recommended by Koesling et al. (2004), Acs et al (2009) and Kuminoff and Wossinnk (2010) among others, politicians should be cautious about changing policy to decrease the uncertainty of the farmers considering conversion.

6.3.5 Individual risk assessment is difficult in reality

The results are conditioned on rational individuals maximising the risk adjusted returns. In reality, risk assessment is difficult for individuals. Examples are the common perception of being better than average car drivers and to overestimate the chance of winning a lottery while underestimating the risk of illnesses such as cancer[9].

[9] Referred to as *innumeracy*, a term meant to convey a person's inability to make sense of the numbers that run their lives (www.innumeracy.com, 2011).

When making a risk assessment, two individuals may come to different conclusions depending on how they value different factors. One factor affecting the decision would be the individual judgement of the ability to adapt organic practices. Another important factor affecting the conversion decision would be the individual risk attitude. A more risk-averse individual would be more hesitant to adapt a new uncertain alternative. However, the results in this analysis does not support Koesling et al (2004) and Kallas et al (2010) suggesting that organic farmers would be less risk-averse.

6.4 Other possible factors acting as barriers to convert

Even if potentially over- and underestimated sources of risks stemming from empirical limitations are dicussed, there could be other reasons acting as barriers of conversion. This is confirmed by interviews with Swedish farmers in Cahlin et al (2008) and international survey results as suggestd by de Lauwere et al. (2004) and Khaledi et al. (2010) among others. Further supporting this are views expressed by initiated persons at Swedish Board of Agriculture, Agriwise, *Lantmännen* and more. Potential factors could be:

- Social attitudes affecting the status of the farmer as well as future prospects of the organic market. The concept of "locally produced products" is becoming popular and is sometimes mistaken as equivalent to organic products. A consumer mixing the concepts would probably prefer the conventional local product without the organic price premium.
- Access to market channels is an important factor and will differ geographically. The demand of organic products seems higher in larger cities compared to rural areas. This difference could be explained by the income differences as organic products are more expensive in general.
- Related to social attitudes and market channels would be the role of the public sector as a forerunner. To increase the share of organic food in the public sector is a part of the Governments target (Swedish Government 2006). The ambition level and target fulfillment varies between the municipalities for different reasons (Organic Forum, 2010). Regulation of public procurements is one reason frequently mentioned as an obstacle. From a risk perspective a rather stable demand from the local municipality could have a positive effect on the prospect of organic production and give access to local market channels. This recognition could also affect the social status for the local organic farmers.
- Family situation where age is a reason why older farmers don't find it worthwile to convert unless the next generation inherits the farm. This would be supported by lower average age for organic farmers than for conventional ones (Cahlin et al. 2008).
- A simple thing such as "you know what you've got but you don't now what you will get" could well affect the behavior. If a conventional farmer feels satisfied with the present situation, why then change to an unfamiliar situation? A longer tradition of conventional farming would increase the opportunity cost in form of skill and know-how to convert to organic farming.
- The difference in appearance between the organic and conventional farm is a potential factor expressed by conventional farmers. The argument would be that organic fields do not appear as green and tidy as conventional fields. This could be regarded as irrational by an outsider but could be one of many factors affecting the conversion decision.

7 Conclusions

Based on the empirical results, the organic crop farm appears to have a lower risk and a higher income level than the conventional crop farm. This is supported by the crop-specific real net returns as well as the farm real net income calculations. The higher risk-adjusted real net income for the organic farm suggests that an organic risk premium would not be motivated and that a rational crop farmer should convert to organic farming. The non-rational behavior may be explained by the common perception of a higher risk in organic crop farming. This may be due to a disproportionate focus on separate prices and yields that seems to be more risky for the organic crops than the conventional ones. This would exaggerate the perceived risk leading to what otherwise would appear to be non-rational behaviour.

An underestimated risk factor might be the economic impact of the conversion period on farm risk and income levels. However, the empirical results suggest that this is compensated for by the organic support payments. Other risk factors underestimated in the study might be the learning curve associated with the adoption of organic practices, regulations and political risk. Additional factors affecting the conversion decision could be social attitudes and access to market channels.

7.1 Further research

Even while this study is an attempt to to use more precise data to represent a typical farm, average statistics will not be representative for actual income variations of the individual farms. Using the same framework and analysing real farm data would be an interesting next step to take. This could potentially reveal important insights to possible barriers of conversion that were hidden by the smoothing effect from the aggregated data used in the current study.

If there is individual farm data available, another interesting area of study would be to look at the potential impact on yields connected to the learning curve. Analysing historical yields from individual farms could perhaps reveal patterns of yield improvement and give insight to the magnitude of the learning curve. This could be valuable input in political discussions of how to create support schemes.

The current study is based on a crop farm. In reality, many farms combine crops and livestock. Regulations regarding animal husbandry add further dimensions to the farm risk. To extend the analysis to include dairy and meat production would perhaps enable more general conclusions about farm risk and potential barriers than the results in this study would allow for.

From a model perspective further insights into the role of risk could be gained by increasing the complexity of the model. As indicated by the results, the conversion period as well as political risk could be important risk factors acting as barriers. An alternative model should allow for this by incorporating risk as well as time dynamics as suggested by Acs et al (2009).

Finally, it seems that factors not directly associated with income risk could be additional factors of importance. A survey analysed using simple factor analysis could categorize the importance of these factors and be of valuable input for policy makers as suggested by Flaten et al. (2010), Khaledi et al. (2010) and Kallas et al. (2004) among others.

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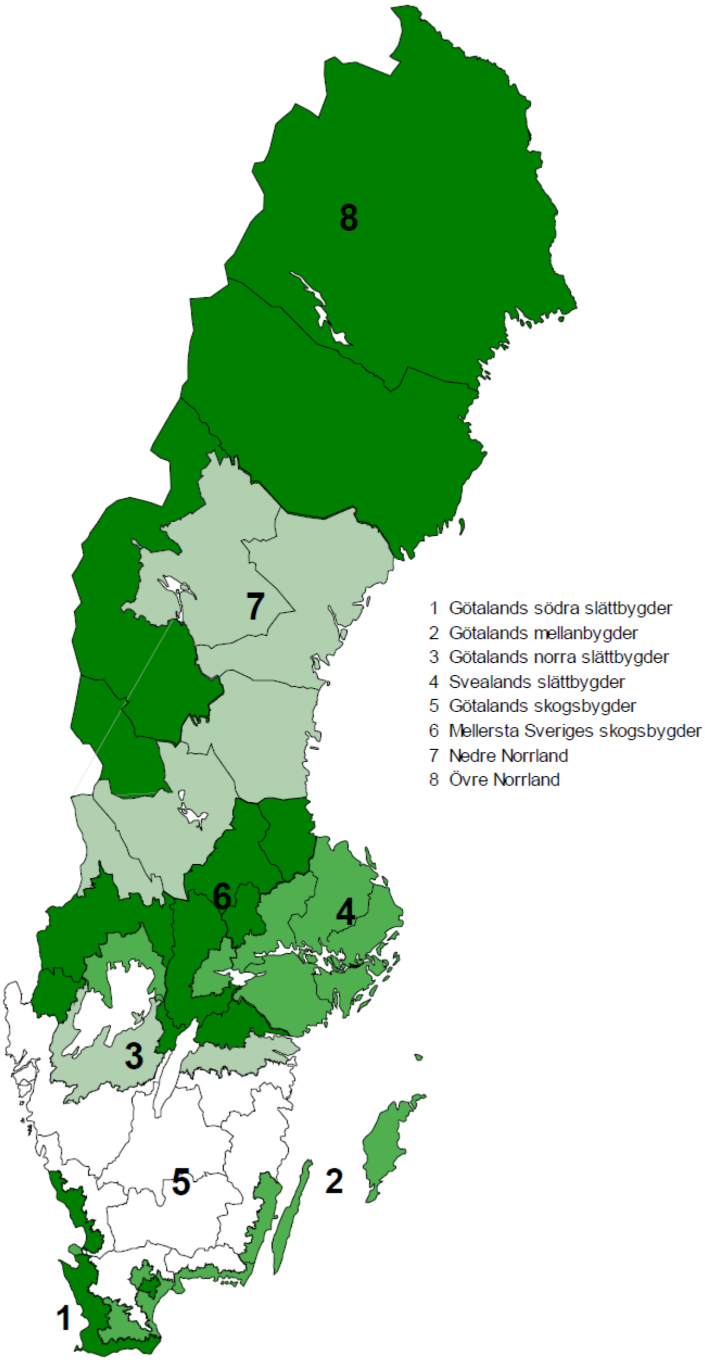
Appendix 1: Map of Swedish production areas



Source: Statistics Sweden, JO16SM1002

Appendix 2: Graphs of yield and nominal price data used in the study

Nominal price (lines, left axis) and yield (bars, right axis) for organic and conventional crop during 2003-2009. C= Conventional, O=Organic, Y=Yield, P=Nominal price.
Sources: Statistics Sweden, Organic Farmers association, Swedish Rapeseed Federation