Available online at www.sciencedirect.com

ScienceDirect

Agriculture and Agricultural Science Procedia 1 (2010) 76–89

Agriculture and Agricultural Science Procedia

International Conference on Agricultural Risk and Food Security 2010

A Monte Carlo model for simulating insufficiently remunerating risk premium: case of market failure in organic farming

Ludwig Lauwers[a,b], Lieve Decock[a], Jan Dewit[c], Erwin Wauters[a]*

[a] ILVO, Institute for Agricultural and Fisheries Research – Social Sciences Unit, Merelbeke, Belgium
[b] UGent, Ghent University – Department of Agricultural Economics, Ghent, Belgium
[c] LBI, Louis Bolk Institute, Driebergen, the Netherlands

Abstract

Starting from the farm management question whether increased risk in nowadays agricultural activities is paid for, a Monte Carlo income simulation model is built to calculated income risk factors and is applied to some organic cropping activities. The organic farming case is often perceived as more risky than conventional farming. The model works with measured as well as subjectively estimated expected volatility of yield, prices and various cost components and simulates return on capital employed (ROCE) and its standard deviation. Results are compared with a "volatility-return" benchmark derived from financial markets. This comparison given an indication whether, first, a risk premium exists, and, second, whether or not it sufficiently remunerates extra risk. Although data availability differs for both systems, they could be robustly compared through decomposing ROCE into yield, price and cost components. Main uncertainties, concerning market failure and capital input, are captured with a sensitivity analysis. Simulations mainly confirm current risk perception, but risk premium is sufficiently high to remunerate extra risk. Sensitivity analysis, however, demonstrates the vulnerability for market failures, but also reveals, unexpectedly, no effects from the absolute capital input.

Keywords: risk; organic agriculture; Monte Carlo simulation; triangular distribution; market failure; return on capital employed; volatility-return benchmarking

1. Introduction

Currently in agriculture, an important upcoming question is whether risk is paid for. Risk is increasing due to more price volatility and yield calamities (Eakin [1], Ericksen et al. [2]) but also due to the introduction of new technologies. This is in particular true for new techniques that are vulnerable for yield failures and for products that may face market failure, which might be the case for organic farming. Indeed, organic farming as an innovative production technique proves to be potentially profitable (Cavigelli [3], Kerselaers et al. [4], Tuzel et al [5]), but

* Corresponding author.
E-mail address: Erwin.Wauters@ilvo.vlaanderen.be; Erwin.Wauters@gmail.com

2210-7843 © 2010 Published by Elsevier B.V.
doi:10.1016/j.aaspro.2010.09.010

conversion is still beneath estimated potential. Besides institutional and socio-psychological aspects, a reason for insufficient conversion may be risk (Lammerts van Bueren [6].

What may be the sources of risk and factor of risk perception? Yield risk may arise from a more narrowly bounded plant protection, but this may again attenuate in the course of time, as organic farming provides a more robust and wealthy environment for crops and animals. Price risk may arise from insufficiently developed market conditions, and even market failure, but also here this may attenuate along the conversion, and even bend towards more market security than in the conventional counterpart. Finally, operational risk will rise when the share of operational costs over fixed factor cost diminishes. Besides income risk, financial risk exists. This is of course less linked to the production system itself and more to the financing strategy, but given the possible liquidity problems during the first conversion years, organic farms may be more dependent on external financing capital, thus face more financial risk.

The objective of this paper is to find out whether organic farming activities are really more risky, and, if yes, whether increased risk is sufficiently paid for. The research concentrates on income risk. To answer these questions, first, a conceptual framework is built to compare the risk-return level of agricultural activities. This framework is used to define and insufficiently remunerating risk premium (IRRP), a measure indicating whether extra risk is (or not) paid for. Next, a Monte Carlo simulation model is worked out to simulate volatility in capital return of agricultural activities. Given insufficient data and lots of uncertainties on real figures, a procedure is proposed to capture subjective information into the quantitative model and to allow for an adequate sensitivity analysis for important but highly uncertain parameters. The model is applied to eight important crops. Subjective estimates on yield, prices and operational costs are used and a sensitivity analysis is worked out for market failure and capital inputs. The final results are expressed in euro per ha, in order to be comparable with extra cost and foregone profit which is the traditional basis for surplus payments in organic farming.

The paper is organized as follows. Starting from theory, a conceptual framework is worked out in section 2. Section 2 also shows the operational model for capital return and how its variability is estimated with Monte Carlo simulation. Results for the eight crops are given in section 3, and discussed in section 4. Section 5 concludes.

2. Risk premium: theory and empirical evidence from financial markets

2.1. Definitions

We define risk premium as the surplus return that compensate for the extra volatility in profit, here return on capital employed (ROCE). The principle behind this can be illustrated in a “volatility – return” graph (figure 1). Volatility not necessarily means risk, but is a generally accepted indicator for risk. The higher the variation the higher the return expectations are, at least in ideal cases, because facing a higher risk not necessarily means a sufficiently increased return. To answer the question whether the surplus return is sufficient for compensating risk, a benchmark needs to be defined. For simplicity, a linear benchmark is chosen, but other functional forms are possible. Benchmarking is a common technique in production economics, in particular those based on frontier analysis (Coelli et al. [7]). With the frontier concept, investments or activities can be situated on the frontier (then they are considered as efficient) or beneath the frontier (and must be seen as inefficient). The risk-free situation yields r_0 as return. A higher risk level would then yield a higher return, r_1, if the associated return is efficient, or located on the benchmark. The efficient risk premium is then

$$ERP = r_1 - r_0 \tag{1}$$

The scheme based on the volatility - return configuration and benchmarking can thus be used to introduce a novel concept, namely inefficiently remunerating risk premium (IRRP), which generally refers to a situation that a risk premium exists but that it is insufficient to remunerate all extra risk, when compared to a reasonable benchmark. We will further on refine this definition based on the alternative situations whether the premium exist or not, and if yes, whether it is sufficient or not, but first, we look for the location of agricultural activities within this risk-return framework. When an IRRP exists, this means that some forgone risk premium (FRP) exists, with

$$ERP = IRRP + FRP \qquad (2)$$

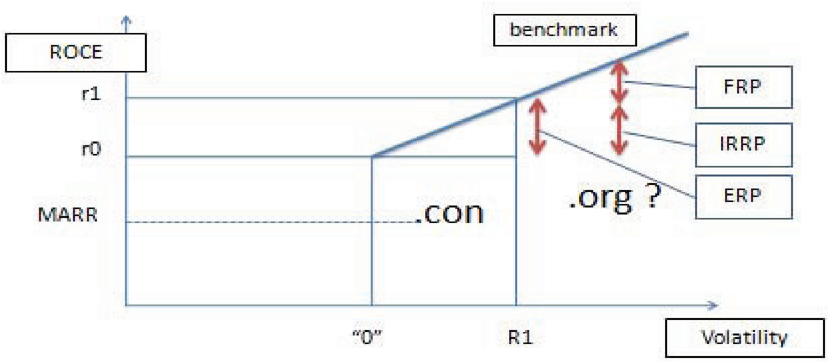

Figure 1. Principle of an efficient risk premium in a volatility-return graph (ROCE = return on capital employed; MARR = minimum acceptable rate of return; FRP = foregone risk premium; IRRP = insufficiently remunerating risk premium; ERP = efficient risk premium)

Hereafter it is postulated, and argued, that agriculture is beneath the frontier that benchmarks financial markets, or in other words that agriculture is inefficient with respect to financial markets. Inefficiency with respect to the benchmark can be persistent. This is most likely the case for agriculture in general. Generally (of course, individual exceptions exist), agriculture faces insufficient remuneration of its production factors' use. This can be easily proven, given empirical labour income statistics in Belgium. Labour income is a traditionally used profit measure in agriculture and calculated as a balance key figure where all but one (=labour) production factor costs are deduced from revenues. For valuing the own capital costs, a risk-free interest rate is used as opportunity cost of the own capital. Even in this optimistic conditions (agriculture is far from non-risky), labour income in agriculture is below the incomes in the remainder of the economy. This observation is not new and can be generalized for other countries Bellerby [8], recent examples are given by Hernandez and Moreno [9], Yang and Zhou [10].

Beside the issue of inadequate factor remuneration, agricultural profits are also more volatile than riskless investments: yield and prices vary across years. So, in figure 1 the volatility-return configuration with capital return as attribute, agricultural activities will be beneath the benchmark. This is conceptually indicated by the dot "con". This also means that the minimum acceptable rate of return (MARR) for agriculture is below other sectors of the national economy. The location of organic ("org") with respect to the conventional counterpart is uncertain.

Evidence exists that profitability may rise, but the impact on risk is hardly known: does conversion to organic farming increases or decreases risk? This is one of the core questions of the current publication.

2.2. Theoretical framework for determining FRP in agriculture

Building further on the conceptual idea of ERP and MARR illustrated in figure 1, Figure 2 brings more details and allows for setting the theoretical framework to derive IRRP and FRP. To simply concepts and graphs, some simplifications are assumed. First, we assume a linear relationship between V an r, at least for the range of (V,r) outcomes we are interested in. The linear function between V an R is a kind of indifference curve. Linearity will simplify, but not substantially bias the estimates.

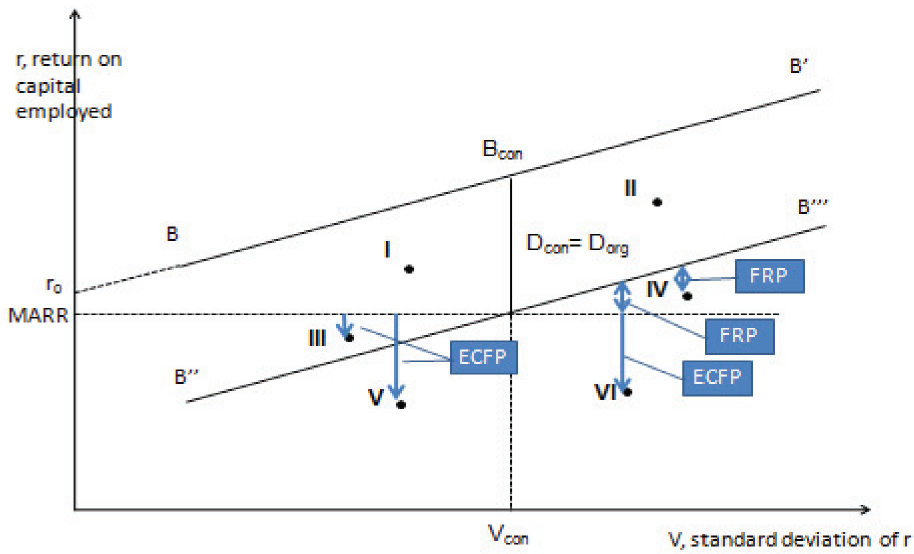

Figure 2. Theoretical framework to derive IRRP and ECFP

Let BB' be a theoretical benchmark of the overall economy ROCE with respect to ROCE volatility. As explained above, there is a good reason to situate conventional agricultural activities beneath this benchmark. So, there will be a distance from the benchmark Dcon, which stands for a return-oriented improvement margin. The distance to reach the efficient return benchmark may reflect a hidden utility attached to farming. Examples of hidden utilities are professional pride (Dessein and Nevens [11]), attachment to rural life, but also immobility of production factors even when they are inefficiently used (see the fixed asset theory of Johnson [12]). For convenience and for comparing agricultural activities or systems, we further assume, that this hidden utility is comparable across agricultural activities. Or, in other words, the difference between the minimum acceptable rates of return (MARR) between the benchmark and agricultural activities is assumed to be constant regardless the volatility level. With this assumption, the overall benchmark BB' can be translated to a more specific agricultural benchmark B''B'''.

$$r = (r_0 - D_{con}) + \alpha V \quad (3)$$

with $D_{con} = B_{con} – MARR$ and, as we assume that hidden utility remains constant across agricultural activities, $D_{con} = D_{org}$

With the information of Vcon, rcon, Vorg, rorg (see 2.3 how to estimate them) and the agricultural benchmark B’’B’’’ the graph can be divided in six zones, with:

$I = \{(V_i, r_i)|V_i \leqslant V_{con} \text{ AND } r_i > r_{con}\}$
$II = \{(V_i, r_i)|V_i > V_{con} \text{ AND } r_i > B_{org} - D_{con}\}$
$III = \{(V_i, r_i)|V_i \leqslant V_{con} \text{ AND } r_i \leqslant r_{con} \text{ AND } r_i > B_{org} - D_{con}\}$
$IV = \{(V_i, r_i)|V_i > V_{con} \text{ AND } r_i > r_{con} \text{ AND } r_i \leqslant B_{org} - D_{con}\}$
$V = \{(V_i, r_i)|V_i \leqslant V_{con} \text{ AND } r_i \leqslant r_{con}\}$
$VI = \{(V_i, r_i)|V_i > V_{con} \text{ AND } r_i \leqslant r_{con}\}$

In the first zone, the (Vi, ri) outcomes are efficient with respect to the (Vcon, rcon) reference: return is higher with less risk. Risk is sufficiently remunerated, and even better remunerated than in the original production system. In zone II, risk is increased, but also does return. As return raises above the B’’B’’’benchmark, also here risk is sufficiently remunerated. In zone III, return falls below the conventional return, but is still above the B’’B’’’benchmark. In this case the difference between the conventional and organic return is composed by extra costs and foregone profit (ECFP)

$$ECFP = r_{con} – r_{org} \tag{4}$$

However, this drop in return isn’t dramatic because the lower risk level compensates largely for this. The inverse happens in zone IV, the risk and return increase and but the increase of the latter isn’t sufficient to reach the benchmark. This is the first zone where an insufficiently remunerating risk premium, IRRP, can be defined:

$$IRRP = r_{org} – r_{con} \tag{5}$$

$$FRP = B_{org} – D_{org} – r_{org} \tag{6}$$

Zone V faces a drop in return, due to ECFP, but similar to the zone III situation, part of it is compensated by a lower risk level. Finally, zone VI represents the worst cases: both risk is increased and return is decreased. FRP is then the entire gap between the conventional return and the B’’B’’’benchmark:

$$FRP = B_{org} – r_{con} \tag{7}$$

2.3. Subjective probability functions

The overall financial market benchmark, the (V_{con}, r_{con}) outcomes and corresponding agricultural benchmark, and finally the (V_{org}, r_{org}) outcomes are derived from subjective information, which provide us with only scarce data. The technique of triangular distribution (Hardaker et al. [13]) is used to derive the probability function from the estimates of a lower and upper bound and the ‘most likely’ value. Return and return variation is estimated for eight major crops.

As it seemed not easy to directly provide estimates for organic farming, some conventional references are produced. So, first, the variation of a given attribute (yield, price, costs) of the conventional farming is estimated from accountancy data. All available data from 1999-2003 is pooled from the data set, so strictly spoken the variation encompasses both variability between farms and volatility. In order not to bias the experts’ estimates, which needs to be done in terms of a triangular distribution, the observed variation is redefined in terms of lower and upper bound and the 'most likely' value:

- most likely = average
- lower bound = average – 2*standard deviation
- upper bound = average – 2*standard deviation

Based on normative differences between organic and conventional agriculture (KWIN), experts' information and some literature, similar lower and upper bound and the 'most likely' values are derived for organic farming. Note that for reconstituting from the triangular distribution a probability function that resembles the most the original distribution, lower and upper bounds that are 2.5 times the standard deviation away from the average are the most appropriate. The basic information for the triangular simulations is given in table 1.

Table 1. Upper and lower bounds of the triangular distributions

	Conventional			Organic		
	Most likely	Lower bound	Upper bound	Most likely	Lower bound	Upper bound
EARLY POTATOES						
Production (kg/ha)	24124	12579	35669	16448	7402	25494
Price(euro/kg)	0.2430	0.1094	0.3768	0.4862	0.3524	0.6200
Operational costs (euro/ha)	2687	1555	3819	3201	2069	4331
Labour (hours/ha)	34	/	/	40.4	/	/
Capital employed (euro/ha)	6000	Sensitivity 5200-6800		6000	Sensitivity 5200-6800	
POTATOES FOR FRESH MARKET						
Production (kg/ha)	35221	18508	51933	21832	5119	38544
Price(euro/kg)	0.155	0.089	0.2204	0.31	0.244	0.376
Operational costs (euro/ha)	1385	501	2269	1348	488	2208
Labour (hours/ha)	27	/	/	34.3	/	/
Capital employed (euro/ha)	4000	Sensitivity 3200-4800		4000	Sensitivity 3200-4800	
POTATOES FOR PROCESSING						
Production (kg/ha)	41483	18910	64055	25719	3146	48291
Price(euro/kg)	0.0699	0.0236	0.1162	0.14	0.0936	0.1861
Operational costs (euro/ha)	1416	646	2186	1348	488	2208
Labour (hours/ha)	27	/	/	34.3	/	/
Capital employed (euro/ha)	4000	Sensitivity 3200-4800		4000	Sensitivity 3200-4800	
WINTER WHEAT						
Production (kg/ha)	8751	6099	11404	6730	4691	8772
Price(euro/kg)	0.1268	0.1046	0.1491	0.2404	0.1986	0.2832
Operational costs (euro/ha)	554	360	749	580	377	784
Labour (hours/ha)	11.5	/	/	14.4	/	/
Capital employed (euro/ha)	1000	Sensitivity 200-1800		1000	Sensitivity 200-1800	
SUMMER WHEAT						
Production (kg/ha)	6152	2720	9585	4680	2068	7290
Price(euro/kg)	0.1269	0.1036	0.1501	0.3173	0.2591	0.3754
Operational costs (euro/ha)	444	285	603	562	361	763
Labour (hours/ha)	10	/	/	14.4	/	/

Capital employed (euro/ha)	1000	Sensitivity 200-1800		1000	Sensitivity 200-1800	
WINTER BARLEY						
Production (kg/ha)	7355	4908	9802	4300	2869	5731
Price(euro/kg)	0.1102	0.0977	0.1227	0.342	0.3029	0.3804
Operational costs (euro/ha)	449	335	563	295	220	369
Labour (hours/ha)	10	/	/	10	/	/
Capital employed (euro/ha)	1000	Sensitivity 200-1800		1000	Sensitivity 200-1800	
LEAK						
Production (kg/ha)	31059	0	68436	17469	0	34938
Price(euro/kg)	0.5716	0	1.43735	1.5041	0	3.0082
Operational costs (euro/ha)	6000	4000	8000	6000	4000	8000
Labour (hours/ha)	673	/	/	851	/	/
Capital employed (euro/ha)	4000	Sensitivity 3200-4800		4000	Sensitivity 3200-4800	
ONIONS						
Production (kg/ha)	51000	31875	70125	30100	0	67725
Price(euro/kg)	0.1000	0.050	0.150	0.22	0.11	0.33
Operational costs (euro/ha)	1963	1227	2699	2920	1825	4015
Labour (hours/ha)	35	/	/	125.4	/	/
Capital employed (euro/ha)	6000	Sensitivity 5200-6800		6000	Sensitivity 5200-6800	

2.4. The Monte Carlo simulation model

Return on capital employed, ROCE, is calculated as follows

$$ROCE = (p*Q - VC - DP - FC - LC - TC)*100/CE \quad (8)$$

where p is price of output; Q is output; VC is variable costs; DP is depreciations; FC is fixed costs; LC is labour costs; TC is tenancy costs; and CE is capital employed.

Return has been simulated for both conventional and organic crops. In each Monte Carlo run, values for p, Q and VC were generated independently. For each simulation, 2000 Monte Carlo runs have been done. The Monte Carlo outcome is then

$$ROCE^S = p^S*Q^S - VC^S - DP - TC - LC - TC)*100/CE \quad (9)$$

with superscript ^{S} indicating an independent Monte Carle simulation. The Monte Carlo simulation has been programmed in Excel, with the add-in application @RISK, with has the function TRIANG(a_1, a_2, a_3), with the arguments a_i being the lower bound, most likely and the upper bound respectively.

The yields, prices and variable costs, p^S, Q^S, VC^S, are derived from a triangular distribution with the parameters mentioned in table 1. Depreciation (DP) is linear over 10 years, fixed cost (FC) are assumed linear with labour costs (mainly tractor and equipment costs), arbitrarily token as 4 euro per ha, labour cost (LC) are derived from normative information (KWIN) and 14 euro per hour, and tenancy costs (TC) are assumed 200 euro per ha. Capital employed (CE) is derived from accountancies, but as it appears hard to allocate to individual activities, it will be subject to sensitivity analysis (see 2.6).

2.5. Benchmarking to financial markets

Before applying to the agricultural sector, a benchmark from the financial world has been elaborated from literature and experts' inquiries. Literature (Stremersch et al.[14], KBC [15], Geboers H. [16] and Bernstein [17]) yielded 11 conservative estimates, comparable to real returns and 5 more optimistic estimates, comparable to nominative returns, this is without taking inflation into account. In the more qualitative approach, the experts (people either familiar with banking, farming or with current investments products) were asked to indicate the expected value of well-known investment alternatives (cash, obligations, stock shares), as well as their upper and lower bounds in a time horizon of 20 years. Thirteen estimates have been obtained, each of them used to reconstitute a triangular distribution from which 10 MC simulations has been done. Data from literature were pooled with the experts' outcomes for a regression analysis which yielded following function:

$$ROCE = 4.38 + 0.36 * SD_{ROCE} \qquad (10)$$

Note that the intercept with the Y axe is 4.38, which means the return for a risk free investment. The highest observed standard deviation coincides with a return of about 15%, so both estimates sounds reasonable as benchmark.

2.6. Sensitivity analysis

Two sensitivity analyses have been done, one for capital employed in five steps (intervals are given in table 1) and one for market failure. Market failure is defined in terms of probability that the price premium for organic products is not received. The sensitivity analysis is done in 6 steps, from no to 15, 30, 45, 60 and 100 % probability of market failure. When market fails, not only the organic products must enter the conventional market, they are assumed to receive a 15% lower price. Note that, although mathematically the same, 100% market failure is not the same as the absence of a organic market during conversion. During conversion, ECFP is more or less known beforehand (and in some countries the basis for public intervention), after conversion, ECFP can be considered as a monetary estimate of risk for market failure.

For the simulation of market failure and corresponding price, a bi-triangular distribution has been generated, each sub-distribution with its own lower and upper bound and the 'most likely' value. The surface beneath total distribution is one, the one under each sub-distribution reflects the probability that market fails or not, respectively.

3. Results

3.1. Simulated ROCE of potatoes for processing

The simulations have been done for 8 crops (table2), but for clarity the results for potatoes for processing will be treated more in detail. Yields, prices and variable costs, p^S, Q^S, VC^S, are derived with Triang(18910;41483;64055), Triang(0.0236;0.0699;0.1162) and Triang(646;1416;2186) respectively for conventional farming, and Triang(3146;25719;48291), Triang(0.0936;0.14;0.1861) and Triang(488;1348;2208) respectively for organic farming. In the convention farming system, the average revenues ($p^S * Q^S$) are 2893 euro/ha (st.dev.= 1022), average gross margin ($p^S * Q^S - VC^S$) is 1473 euro/ha (st.dev = 1066). In the organic farming system, the average revenues are 3617 euro/ha (st.dev.= 1389), average gross margin is 2289 euro/ha (st.dev = 1443). With 3200 euro/ha average capital employed, 27 hours work at 14 euro/hour ROCE, 4 euro FC per hour worked, 640 euro/ha DP en 200 euro/ha TC we obtain a ROCE of 4.88 % (st.dev. = 33.9). For organic farming this is 24.84% (st.dev. = 44.9). With the most likely value of CE (4000 euro/ha), lower ROCE and volatility values are obtained (table 2).

Table 2. Return on capital employed (ROCE) and its volatility of eight major arable crops, on conventional and organic farming systems

	Conventional farming		Organic farming	
	ROCE	Volatility	ROCE	Volatility
Early potatoes	19.3	30.1	46.8	34.2
Potatoes for fresh market	64.4	36.8	95.8	55.5
Potatoes for processing	-0.03	27.2	16.0	36.4
Winter wheat	-5.2	17.7	38.2	25.0
Summer wheat	-24.2	19.8	26.4	36.7
Winter barley	-22.0	12.6	89.4	32.1
Leek	72.7	355.7	102.6	400.4
Onions	18.0	22.4	10.5	57.8

Potatoes for fresh market have much higher returns, but also higher volatility, as they have less price dampening effects of storage. Early potatoes on the other hand also face lower volatility because of less volatile early-bird prices? Cereals crops are much less volatile. Negative returns are due to the fact that own labour already received full remuneration, magnitude of negative values are a result of various leverage effects. Leak is a highly speculative but lucrative crop. Organic onion production is less profitable than the conventional way.

3.2. Sensitivity to assumed CE

When capital employed in potatoes for processing ranges from 3200-4800 euro/ha, the resulting ROCE drops from 5% to -3% for conventional farming, and from 25% to 10% for organic farming. When market fails, not only risk increases (a bit), but returns decrease dramatically. With only 0 or 0.15 probability of market failure, organic production of potatoes for processing is still in zone II with respect to the conventional reference. Higher probabilities of market failure make the (V, r) outcomes to shift to zone IV (30% market failure) and zone VI (60% and 100 % market failure).

3.3. The per ha foregone risk premium

Except for onions, the risk premium is sufficient to pay for increased volatility, even compared with the financial market benchmark. Only when 30% market failure is assumed, the risk premium becomes insufficient with respect to conventional agricultural benchmark. Although the ROCE varies drastically according to the CE sensitivity assumptions, and thus ECFP, IRRP and FRP, expressing the foregone risk premium on a per-ha basis reveals insensitivity to CE assumptions (table 3).

Table 3. Expressing the foregone risk premium on a per ha basis, case of potatoes for processing and 30 % market failure

CE (euro/ha)	Efficient ROCE (% on CE use)		Distance to benchmark	FRP	FRP
	Conventional	Organic (30% market failure)	(% on CE use)	(% on CE use)	(euro/ha)
3200	16.7	22.5	16.8	5.11	163.5
3600	15.3	20.5	17.7	4.54	163.5
4000	14.2	18.8	18.3	4.09	163.5
4400	13.3	17.5	18.9	3.72	163.5
4800	12.6	16.4	19.3	3.41	163.5

Higher values of market failure increase the distance to benchmark, which is then not only a FRP, but also ECFP. However, final expression on a per ha basis reveals insensitivity to the CE assumptions. In the case developed in table 3, this is 163 euro per ha. This is a rather straightforward result of income and return calculations. Indeed, comparing ROCEcon and ROCEorg can be written as follows:

$$\Delta ROCE = (I_{org} - CE/5)CE - (I_{con} - CE/5)/CE \tag{11}$$

With I_{org} and I_{con} the incomes of organic and conventional production without yet remunerating capital input.

This observation stands as long as CE for conventional and organic farming is supposed to be the same. This is most likely not the case, but we can hold the principle. As the capital input per unit of activity is the most difficult to estimate, holding the principle of equal CE input allows for further simplifications, amongst others for simulating the effect of market failure.

3.4. Sensitivity to market failure

The forgone risk premium, expressed in euro per ha, can now be calculated for various assumptions in market failure. With “no market failure”, all crops except one face sufficiently remunerating risk premiums (table 4). In the case of onions, the ECFP can, however, hardly be seen as a risk factor , and is exactly the same amount as could be derived in a deterministic way to estimate the impact of conversion (De Cock et al.[18]). Only the differences between ECFP+FRP faced when market fails and the deterministic ECFP can be seen as a monetary value of extra risk. The vegetable crops are highly vulnerable to market failure, cereals are rather insensitive. The potato crops show an intermediate sensitivity.

Table 4. Changes in ECFP and FRP due to increased market failure

Crop	ECFP+FRP, in euro/ha, when market failure equals					
	0%	15%	30%	45%	60%	100%
Early potatoes	0	0	20	748	1394	
Potatoes for fresh market	0	0	389	969	1484	
Potatoes for processing	0	0	164	488	765	
Winter wheat	0	0	0	81	217	
Summer wheat	0	0	0	68	204	
Winter barley	0	0	0	0	0	
Leak	0	2253	4233	6599	8555	
Onions	1216	1948	2629	3255	3832	
	(0)	(732)	(1413)	(2039)	(2616)	

4. Discussion

In order to find an answer to our research questions – is there extra volatility in organic production activities and is it paid for – we needed a simplified concept given the data scarcity. The question arises whether the results can lead to general conclusions given these simplifications and assumptions. One of the major assumptions was that hidden utility of organic farming equals the conventional one and that both can be equally benchmarked to a linear volatility-return trade-off curve as found in financial markets. In practice, this will, however, hardly be the case. Moreover, finding a financial-markets benchmark complicates things. Ideally, the concept of ERP, IRRP and FRP should be benchmarked to an observed volatility-return frontier in agriculture. But up to now we miss the necessary information. Larger data sets on (V, r) outcomes of various agricultural systems are needed, but even then the challenge would remain what type of frontier (linear or not) to construct.

The research is concentrated on individual cropping activities. This rises the problem of allocating fixed costs, but also that we ignore co-variation between the various activities. Diversification can be seen as an answer to price volatility and various risk increases (Yang [19]). For convenient comparisons, also here adequate data are lacked. In particular, it is unclear whether or not we can expect higher correlation between separate activities' outcomes, given the specific nature of organic farming and its supply chain. Despite data scarcity, current research already enabled to unravel main drivers for risk increase, and these are rather to be found in the market structure, rather than in traditional risk sources such as yield, costs and price variation. In particular for vegetables, high dependency on a well-organised market structure is observed. The data used in the simulation (for the conventional benchmark) comes from pooled FADN data, which encompass both inter-farm variability and volatility. It might lead to some overestimation of volatility, but as this information is used for subjectively estimating organic data, overestimation is true for both. Indeed, leaving the data pooled gave a more meaningful estimation from experts, who were not always able to unravel variability and volatility.

Finally, sensitivity analysis to CE revealed a constant FRP, when expressed in euro per ha. As stated above, this is due to the assumption that CE input in organic is the same as in conventional, which is highly discussable. In most cases, however, capital use after conversion will increase, in particular due to new investments on top of existing ones (De Cock et al., 2010b). As long as $CE_{org} > CE_{con}$, differences in costs can be captured in ECFP, things become more complicated when $CE_{org} < CE_{con}$.

5. Conclusion

Our simulations show that FRP (foregone risk premium) is mostly zero for the major crops in Belgian agriculture, thus risk is paid for! Only when assuming market failure, this is when the expected higher price for organic products is not reached, FRP will come up to levels that constitute a major part of gross margins. This confirms firm level research (Lien et al. [20]), however, added value of current paper is the analytical approach. It not only simulates absolute values of return and volatility, it allows for interpretation in terms of utility attached to changed return and volatility outcomes. This interpretation is not only more relevant –what is the value of increased volatility?-, but also simply its communication. Foregone risk premium per ha is easy to understand, and rather robust.

As a general conclusion, conversion to organic farming may lead increased profits, of which the variability not necessarily increases. Although largely subjective, reasonable estimates of yield, price and cost volatility do not lead to substantial profit volatility. On the contrary, some institutional factors, such as market organisation, may completely invert this conclusion. For the agricultural entrepreneur, conversion to organic agriculture is a radical innovation with lot of uncertainties. Results of our research may lead to the conclusion that agronomic on-farm factors to dampen out revenues and costs volatility may play a role, but more vulnerability is expected from change in the institutional environment. So, entrepreneurship should encompass good market knowledge and tight institutional arrangements.

Policy instruments to keep financial risk during and after conversion reasonable, need to be based on above insights. Although support payments continue to play an important role in the profitability of organic farming (Offerman et al. [21]), above conclusions show more need for institutional support then mere premiums. So, this would mean that governmental support programs should pay more attention to solid market mechanisms, regardless whether these institutions are private or publicly organized.

6. References

1. Eakin, H. (2005). Institutional change, climate risk, and rural vulnerability: Cases from central Mexico. World Development, 33(11), 1923-1938.
2. Ericksen, P.J., Ingram, J.S.I., Liverman, D.M. (2009). Food security and global environmental change: emerging challenges. Environmental Science & Policy, 12(4), 373-377.
3. Cavigelli, M.A., Hima, B.L., Hanson, J.C., Teasdale, J.R., Conklin, A.E., Lu, Y.C. (2009). Long-term economic performance of organic and conventional field crops in the mid-Atlantic region. Renewable Agriculture and Food systems, 24(2), 102-119.
4. Kerselaers, E., De Cock, L., Lauwers, L., Van Huylenbroeck, G. (2007). Modelling farm-level economic potential for conversion to organic farming. Agricultural Systems, 94, 671-682.
5. Tuzel, Y., Gul, A., Tuncay, O., Anac, D., Madanlar, N., Yoldas, Z., Gumus, M., Tuzel, I.H., Engindeniz, S. (2005). Organic cucumber production in the greenhouse: A case study from Turkey. Renewable Agriculture and Food Systems, 20(4), 206-213.
6. Lammerts van Beuren, L. (2002). Organic plant breeding and propagation: Concepts and strategies. Phd-thesis, Wageningen University and Research Centre.
7. Coelli, T., Lauwers, L. & Van Huylenbroeck, G. (2007). Environmental efficiency measurement and the materials balance condition. Journal of Productivity Analysis, 28, 3-12.
8. Bellerby, J. (1956). Agriculture and Industry Relative Income. London, Macmillan, 57p.
9. Hernandez, R., Moreno. J. (2009). Standard of Living in Rural Castile and Leon. An Anthropometric Perspective, 1840-1970. Historia Agraria, 47, 143- 156.

10. Yang, D.T., Zhou, H. (1999). Rural-urban disparity and sectoral labour allocation in China. Journal of Development Studies, 35(3), 105-133.
11. Dessein, J. & Nevens, F. (2007). 'I'm sad to be glad'. An analysis of farmers' pride in Flanders. Sociologia Ruralis, 47(3), 273-292.
12. Johnson, G.L. (1955). Results from production economic analysis. Journal of Farm Economics, 37(2), 206-222.
13. Hardaker, J.B., Huirne, R.B.M. & Anderson, J.R. (1997). Coping with risk in agriculture, New York, CAB International, 274 p.
14. Stremersch, J., Van Broekhoven, E., Janssens, J. & T. Vermeiren (2007). Persoonlijke Financiële Planning, Gids voor een integraal vermogensbeheer. Uitgeverij Tijd, ISBN: 9789071986857
15. KBC (2004). Beleggingsproces: Achtergrond & Methodologie. KBC Asset Management, 2, 4p. (http://www.kbcam.be/funds/are/macro/aanpak/Backgr-Method_risk-return_nl.pdf)
16. Geboers, H. (2006). Doorzichtige optimale beleggingsmethoden. Eindverhandeling Graad Handelsingenieur major Accountancy en Financiering, Universiteit Hasselt, 118p.
17. Bernstein, P. (2006). Against the Gods: The Remarkable Story of Risk. John Wiley & Sons, New York, p252-253.
18. Decock, L., Dewit, J. & Lauwers, L. (2010b). Full paper on factors justifying direct payments to organic producers.
19. Yang, W. (2007). Institutional reforms, agricultural risks and agro-industrial diversification in rural China. Journal of the Asia Pasific Economy, 12(3), 386-402.
20. Lien, G., Hardaker, J.B., Flaten, O. (2007). Risk and economic sustainability of crop farming systems. Agricultural Systems, 94(2), 541-552.
21. Offermann, F., Nieberg, H, Zander, K. (2009). Dependency of organic farms on direct payments in selected EU member states: Today and tomorrow. Food Policy, 34(3), 273-279.