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ABSTRACT

Farm risk management for income stabilization is on-going issue. An applied work has been performed to measure farm risk using a stochastic model. Risk management tools, with symmetric as well as asymmetric impacts, are then tested and compared through ad hoc statistics. Normal farm business risk can be efficiently managed using a precautionary saving provision. Farm revenue insurance is found as the most efficient asymmetric tool for dealing with climatic and market shocks. The linkage between these complementary tools can be adjusted upon market environment.

RÉSUMÉ

La gestion du risque agricole afin de stabiliser le revenu est un sujet permanent d'analyse. Un modèle stochastique a été réalisé afin de mesurer le risque agricole. Des outils de gestion du risque, avec une démarche de gestion symétrique et asymétrique, ont été modélisés afin d'estimer leur impact et de comparer leur performance. Ainsi, le risque normal peut-il être géré efficacement par une épargne de précaution. L'assurance chiffre d'affaires de l'exploitation agricole peut être considérée comme l'outil le plus performant pour la gestion de chocs climatiques et de marché. La liaison entre ces deux outils peut alors être ajustée en fonction de l'environnement de marché.

Key-words: Comparative, performance, risk, management, tools

Mots-clés : Evaluation, performance, outils, gestion, risque

Introduction

Agricultural specific risk is related to climatic, sanitary, market and environmental causes. Such risk may be normal but also catastrophic. It affects farm competitiveness through sub-optimal production and investment choices (Anderson et Danthine 1980, Gollier 2007). It is therefore a private as well as political issue that is increasingly rising with changes in the European Common Agricultural Policy (Meuvissen *et al.* 1999, Cafiero et al. 2005, 2007). However, most studies are qualitative (OECD 2000, Alizadeh *et al.* 2005, European Commission 2005). Few studies have been performed for quantifying the agricultural risk and analyze comparative performance of well-known tools currently offered or not by the market. Research was therefore required on individual tool performance for revenue risk management and optimal tool coordination, basically between precautionary saving fund - a symmetric risk management approach - and risk selling tools considered - an asymmetric approach.

The aim of the paper is to compare the performance of risk management tools on farm income. It presents first a general model for quantifying agricultural risk designed for analyzing various types of farm within different market environment and agricultural policies. The model, applied to the segment of French grain farm (wheat, corn, barley and rapeseed), is then used for simulating asymmetric risk management tools and then compare their impact in terms of pertinent statistics (mainly coefficient of variation and Value at Risk). The paper is then presenting a tentative optimal use of the most efficient tool for asymmetric risk management with the smoothing tool, the precautionary saving provision.

1. The stochastic model of farm income

The stochastic model is designed for eliciting the farm income distribution function using a Monte Carlo simulation. The impact of risk management tools is analyzed through their impact on the farm income distribution function. All simulations have been performed using the software @RISK (Palisade 1997, 2006).

1.1. The deterministic model

The grain farm income (FI_t) is computed as the following:

$$FI_t = \Sigma\, S_{i,t}.(P_{i,t}.r_{i,t} + SFP_{i,t} - VC_{i,t}.r_{i,t}) - FC_t$$

with: $P_{i,t}$ the average price for product i and year t
$r_{i,t}$ the agricultural yield for product i and year t
$S_{i,t}$ the acreage for product i and year t
$VC_{i,t}$ the variable costs per acre for product i at year t
$SFP_{i,t}$ the single farm payment per acre for product i at year t
FC_t the farm fixed costs at year t

A representative farm in the Northern part of France is used to parameter the deterministic model. The farm is 230 hectares, with 54 % of wheat, 17 % of barley, 5 % of corn, 8 % of peas, 16 % of rapeseed, 0 % of sugar beet et 1 % of set-aside (Table 1).

Table 1: Deterministic model of farm income - Northern France average farm

				Sales	Sales	Single farm payment	Single farm payment	Revenue	Revenue	Variable	Variable costs	Gross
	Surface (ha)	Yield (t/ha)	Prix (€)	/ha (€)	Total (€)	/ha (€)	Total (€)	/ ha (€)	Total (€)	Costs/ ha (€)	Total (€)	Margin (€)
Wheat	124	8.5	125	1063	131,750	400	49,600	1,463	181,350	333	41,292	140,058
Barley	38	7.1	117	834	31,698	400	15,200	1,234	46,898	305	11,590	35,308
Corn	11	8.7	85	743	8,178	400	4,400	1,143	12,578	350	3,850	8,728
Peas	18	4.9	120	584	10,509	460	8,280	1,044	18,789	283	5,094	13,695
Rapeseed	37	3.9	210	814	30,119	400	14,800	1,214	44,919	330	12,210	32,709
Sugar beet	0	73	35	2555	0		0	0	0	862	0	0
Set aside	2					400	800	800	800	61	122	678
Total	230				212,254		93,080	305,334			74,158	231,176
									Fixed costs (€) :			170,709
									Farm income (€) :			60,467
									Résultat / ha (€) :			262.9

1.2. The stochastic model with parameterization

It is considered that climatic and market risks are affecting farm income through the individual yield and price distribution functions of each production. The costs are deterministic. More precisely, it is not considered any risk on the energy market. Correlations between yields and prices and cross-correlations between crops are parameterized, designing natural farm product diversification. Finally basis risk is not considered as it should be marginal with respect to the market risk and therefore the revenue risk.

Historical French or European prices are meaningless for estimating any price distribution as they reflect more a public policy than a market behavior. Therefore, distribution functions have been chosen upon price time series on various countries throughout the world. Crop prices were found in FAO statistics for sixteen years. Two sets of prices have been set. The first one – scenario 1 - is based upon 2006 price levels as available in published statistics. The second one – scenario 2 - has been created for simulating a « general » price level which creates the same income level without the direct payment per hectare from the 2003-2013 CAP. The standard deviation is considered constant in percentage of the mean. Table 2 presents the two sets of prices.

Table 2 : Price distributions for main crops

	Distribution	Statistics scenario 1		Statistics scenario 2		% for deriving standard deviation from mean
		Mean (€)	Standard deviation	Mean (€)	Standard deviation	
Wheat	Normal	125	21.6	183	31.1	17 %
Barley	Normal	117	20.1	161	27.3	17 %
Corn	Normal	85	12.7	120	18.0	15 %
Rapeseed	Normal	210	31.5	294	44.1	15 %

Normal distributions are stationary and symmetric[1]. The price risk as reflected by the percentage of standard deviation in relation to the mean value has been set in relation with international prices (Price STAT from FAOSTAT- http://faostat.fao.org).

Using French statistics, the crop yields are following beta distributions, as presented in Table 3.

Table 3 : Main crop yield distributions in France

	Distribution	Parameters				Mean	Standard deviation	Skewness	Kurtosis
		α1	α2	Minimum	Maximum				
Wheat	Beta	7.0	2.8	3.5	10.5	8.55	0.96	-0.53	2.92
Barley	Beta	3.7	2.4	4.4	8.9	7.10	0.82	-0.29	2.45
Corn	Beta	3.2	1.5	6.5	9.8	8.75	0.64	-0.55	2.62
Peas	Beta	2.9	2.0	3.8	5.6	4.90	0.36	-0.26	2.30
Rapeseed	Beta	5.3	2.3	2.9	4.3	3.89	0.22	-0.52	2.81
SugarBeet.	Beta	3.0	2.0	67	77	73.0	2.00	-0.29	2.30

The beta distributions are stationary and asymmetric. The computed values of skewness for the main crops are negative, meaning that yield may increase slightly from the mode but it may decrease strongly. In addition, individual yield variability may be much higher than national yield variability for local climatic problems (hail, water excess or deficit at specific dates in relation with plant development). The total annual indemnity of such farmers is

[1] Lognormal and LogLogistic distributions have also been estimated against data. These alternative estimations do not bring any significative impact differences on farm income distribution.

inducing a premium rate on multiple peril crop insurance in France. Data on French crop yields have been provided by FAOSTAT and individual risk coefficients come from insurance experts.

Parameterisation of cross-correlations within the farm portfolio

Correlations and cross-correlations between variables should be set within the model. The more the products are substitutes, the higher is the positive correlation between prices (and reciprocally). In addition, independent and local markets bring high negative correlation between prices and yield. Reciprocally, international markets tend to lower the correlation between price and yield.

Two extreme scenarios have been designed. The first one is set upon the hypothesis of a « close » European market, i.e. with measures of isolation such as flexible levies. Under this hypothesis, the negative correlation coefficients price/yield are high (Table 4). The second scenario is considering an open international European market where prices have no or low correlation with national yields (Table 5).

Table 4: Correlation table for the scenario « closed market »

	Wheat yield	Wheat Price	Barley yield	Barley price	Corn yield	Corn price	Rapeseed yield	Rapeseed Price
Wheat yield	1							
White price	-0.5	1						
Barley yield	0.8	-0.4	1					
Barley price	-0.5	0.8	-0.5	1				
Corn yield	0.5	-0.2	0.5	-0.2	1			
Corn price	-0.4	0.8	-0.2	0.5	-0.5	1		
Rapeseed yield	0.4	-0.2	0.1	-0.3	0.3	0.1	1	
Rapeseed price	-0.4	0.2	-0.3	0.4	-0.4	0.4	-0.4	1

Table 5: Correlation table for the Situation de marché ouvert

	Wheat yield	Wheat Price	Barley yield	Barley price	Corn yield	Corn price	Rapeseed yield	Rapeseed price
Wheat yield	1							
Wheat price	0	1						
Barley yield	0.8	0	1					
Barley price	0	0.8	0	1				
Corn yield	0.5	0	0.4	0	1			
Corn price	0	0.8	0	0.7	-0.2	1		
Rapeseed yield	0.4	0	0.2	0	0.1	0	1	
Rapeseed price	0	0.2	0	0.2	0	0.2	0	1

2. Farm risk measurement

In fine, we consider farm risk as the distribution estimated function of income, as a margin before private payment to the farmer. The distribution function presents statistics such as mean, mode, median, standard deviation, skewness and kurtosis which describe the ultimate farmer risk. In addition, percentiles of probability scales (from 5 to 95 %) indicates income values that are of interest for the farmer with respect to financial targets of risk management strategies. These percentiles are also called Values at Risk of the portfolio farm under risk management strategies.

For instance, the farm risk for the representative French farm, with decoupled direct payments and high negative price-yield correlation values is illustrated in figures 1 and 2. The estimated margin distribution has been set by Monte Carlo simulation using 5.000 random samples. Adjustments of distribution functions have been performed from data distributions using the chi-square method.

Figure 1: Distribution of farm income with 2006 prices, with direct payments and high correlation values

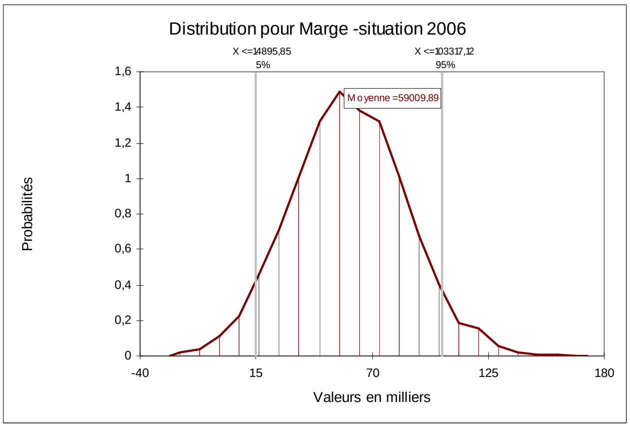
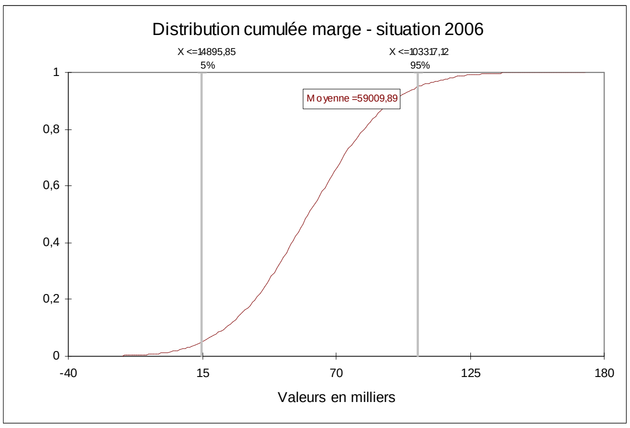


Figure 2: Cumulative distribution of farm income with 2006 prices, with direct payments and high correlation values



The main characteristics of the farm risk (main crops in the northern part of France) are then presented in table 6.

Table 6: Characteristic of the farm risk

	Distribution	Mean	Standard deviation	Coeff of variation	Skewness	Kurtosis	VaR5%
Estimated margin		59,009	26,927	0.46	0.08	3.07	14,895
Adjusted margin	Normal	59,010	26,927	0.46	0.00	3.00	14,718

To elicit risk assessment, the characteristics of farm risk under three different environment scenarios are presented in Table 7. The coefficients of variation are strongly increasing from 0.46 to 0.67, a 46% increase when single farm payments (SFP) are balanced by an equivalent price increase. Conversely, the impact of single farm payments on a pure market basis is a 30% risk decrease as measured by the coefficient of variation.

Table 7: Farm margin risk under market environments

Farm Margin	Distrib.	Moyenne	Ecart type	Coeff. variation	Asym.	Aplat.	VaR5%
« closed » market with SFP	Normal	59,009	26,927	0.46	0.08	3.07	14,895
« closed » market without SFP	Normal	58,790	39,195	0.67	0.12	3.02	- 4,679
« open » market with SFP	Normal	59,865	35,163	0.59	0.15	3.03	3,269
« open » market without SFP	Normal	59,912	50,634	0.84	0.15	3.03	- 21,586

3. The risk management tools

The tools considered for analysis are first the precautionary saving provision for symmetric risk management and an insurance contract on farm revenue for asymmetric risk management. The insurance contract on farm revenue (or farm total sales) is conceptual as it does not exist around the world. It is known that this insurance contract brings practical management difficulties to set (changes of crop acreage from year to year for instance) and to set indemnities (high expertise costs due to quasi- systematic required expertise on the field). The insurance contract on farm revenue has been found more efficient with respect to cost than three other tools of asymmetric risk management, the wheat price option, the wheat crop insurance and the wheat sales insurance[2].

3.1. The precautionary saving provision analysis

The provision is a smoothing mechanism. When the farm income is high, the farmer is allowed to save free of fiscal and social taxes a percentage of its sales. This saving is invested in low-risk bonds. When the farm income is low, the farmer is allowed to withdraw from the savings in order to increase the farm income. It is a very traditional and effective mean of managing agricultural business risk. The mechanism has been implemented in many countries around the world under various names such as mutual funds in English or *caisse de stabilisation* in French. International agreements on products in the seventies and even more recent counter-cyclical measures and subsidies are part of the same story.

[2] This research result is presented in a working paper n°XXX UMR SMART (2007) and submitted for publication in *Economie & Sociétés, Spring 2008 issue*

Most of these applied mechanisms failed due to practical and political issues. First, it is difficult to define economically what is a high farm price (or income) and what is a low farm price. To elicit the pivot level for smoothing price or income is not trivial. Second, any pivot price based upon cost consideration is subject to strong political pressure. Very quickly, risk management and price (or income) support are mixed with negative consequences.

To overcome the difficulties and keep advantage of the basic smoothing mechanism, two types of pivot have been tested. The first type of pivot is an historical moving average of farm sales. It has been chose a three-year moving average and an exponential smoothing, which is an improved moving average technique[3]. The second type of pivot is the Value at Risk with a high percentage. For instance a Var(40<X<50%) is close and lower than the expected long term mean of a stochastic variable.

Using the pivot as defined previously, the amount of saving is a percentage k of the total sales and the withdrawal is 100% of the “loss” below the pivot

- the moving average pivot value

The smoothing impact is mainly due to the maximum amount allowed of the precautionary saving provision. This maximum value is compute das a percentage of the pivot value of total sales. Other parameters have been checked such as the percentage of saving allowed per year or various asymmetric tunnels around the pivot value.

The coefficient of variation decrease is proportional to the amount of the total saving allowed as presented in table 8.

Table 8: Reduction of CV in relation with percentage of savings

% of savings on pivot value	Reduction in coefficient of variation
10 %	8 to 10 %
20 %	19 to 21 %
30 %	30 to 34 %

As expected, the smoothing approach keeps a symmetric distribution of farm margin (skewness = 0,02 and kurtosis = 3,0) whatever the maximum level of the saving provision.

The simulation performed develops price series without autocorrelation, which is far from real world price time-series. Therefore, a moving average process (MM3) has been used to develop autocorrelation within simulated price series. In doing so, it is observed a restricted effect of the precautionary saving provision. The provisions performs as an additional order of the moving average process. As a consequence, another pivot value is necessary, not a relative value but a fixed one. Different values at Risk of the farm sales were then used.

- the VaR pivot value

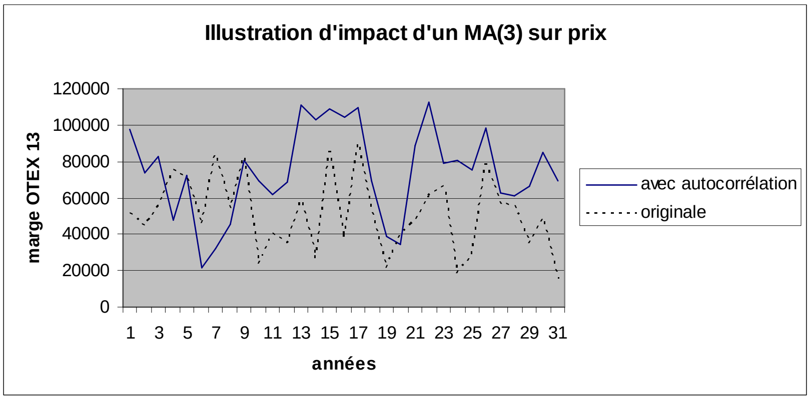
Figure 3 presents an original set of thirty farm margin values derived from random drawn market prices by @RISK as well as a set of margins computed from MA(3) derived prices.

[3] Calculus of the exponential smoothing pivot of Farm Total Sales (TS) with β coefficient:

$TS_{t+1} = (TS_t + \beta.\ TS_{t-1} + \beta^2.\ TS_{t-2} + \beta^3.\ TS_{t-3})/\ (1 + \beta + \beta^2 + \beta^3)$

This second set of margins is supposed to reflect better a real agricultural market environment (with single farm payments).

Figure 3: Sample of original and autocorrelated grain farm income series



The mechanism of the precautionary saving provision is applied to the autocorrelated series. Three parameters have been checked in order to analyze the impact of the provision on the farm margin:

- the pivot level on a VaR 10 to 40% range

The VaR 10 % is allowing to save very quickly and to withdraw barely. A VaR above 50 % does not show any evidence of savings as withdrawals are too frequent,

- the rate of savings into the provision on a range from 20 to 100 % and rate of withdrawal of 100 %,
- the maximum level of savings on a range from 10 to 50% on farm total sales.

The main results of the precautionary saving provision (open market with SFP scenario), as presented in Table 9, are close to expected direct implications of smoothing a stationary series. Even though, it is noticed a significant change in the mean value of the farm margin with respect to the VaR value. This is related to the final value of the provision. For a low value at risk, for instance VaR10%, the savings allowed is saturated rather quickly and withdrawals are rare. The saving is maximal at the end of the simulated scenario. When the saving value is added (on average) to the farm margin mean, the initial value of the farm margin is reached.

Table 9: Main results of the precautionary saving provision (open market with SFP)

	Mean		Coeff of Variation		Value at Risk 5 %	
Original margin	57,663	-	0.59	-	4,300	-
VaR 10% k=0,5	50,405	- 12 %	0.41	- 30 %	4,558	+ 6 %
VaR 10% k=0,25	53,847	- 7 %	0.49	- 17 %	4,515	+ 5 %
VaR 20% k=0,5	53,331	- 7 %	0.36	- 39 %	5,175	+ 15 %
VaR 20% k=0,25	55,497	- 3 %	0.47	- 21 %	4,730	+ 10 %
VaR 30% k=0,5	55,341	- 3 %	0.33	- 44 %	5,203	+ 21 %
VaR 30% k=0,25	56,497	- 2 %	0.46	- 21 %	4,859	+ 13 %
VaR 40% k=0,5	57,381	0 %	0.31	- 48 %	5,676	+ 32 %

VaR 40% k=0,25	57,522	0 %	0.44	- 26 %	4,988	+ 16 %

It is also noticed as expected a decrease of the coefficient of variation values when the pivot value is increased. For instance, the coefficient of variation is reduced from 0.59 to 0.31 from original value to a provision mechanism with a Var40% pivot and a 50% rate of savings (and a maximum of savings 50% of sales). The VaR of the farm margin distribution is then improved from 4,300 euros to a maximum value of 5,676 euros, a 32% increase.

Sensitivity results were checked in the third dimension, the maximum amount of savings. Basically, the smoothing performance is weak for low values of the pivot, whatever the maximum amount of savings allowed. Basically, the impact of the saving amount is limited to a year after year accumulation of savings. To the opposite, with high values of the pivot – such as VaR 40%, the smoothing performance is much improved. The CV level of 0.31 is reached as soon as the level of savings is equal or above 30 %. Savings and withdrawals are well balanced and the smoothing performance is maximized.

Table 10: Sensitivity of maximum saving percentage (open market with SFP)

Savings in % of total sales (k = 0.5)	CV	VaR 5%
10 %	0.45	4,520
20 %	0.39	4,760
30 %	0.31	5,610
40 %	0.31	5,690
50 %	0.31	5.760

Using @RISK Optimizer (Palisade 2006), it has been checked grain farm optima values for the three parameters (VaR, percentage of savings and maximum value of savings) for different market scenarios.

Scenario 1 “minimum of farm risk”: high price-yield correlations with single farm payment. The optimal parameters are the following. First, the CV is minimized in increasing the VAR up to 50%. As the VaR 50% from sales is estimated from price and yield distributions, the VaR is then fixed to 40% of the sales distribution. Second, upon a VaR 40% pivot, the CV is asymptotically minimized with a 50% saving rate and 100% withdrawal from the pivot rate. And third, under the previous settings, the CV is minimized with a maximum saving of 20% of total sales.

Scenario 2 “maximum of farm risk”: low price-yield correlations without single farm payment, but equivalent high prices. The optimal parameters are the following. First the CV is minimized in increasing the VaR up to 50% as previously. It is then fixed at a 40% level. Second, upon a VaR 40% pivot, the CV is asymptotically minimized with a 80 % saving rate and 100% withdrawal from the pivot rate. Third, under the previous settings, the CV is minimized with a maximum saving of 50% of the total sales.

3.2.The compared performance of asymmetric risk management tools

Four asymmetric risk management tools have been studied, a put option on wheat price, a crop yield insurance on wheat, a revenue insurance on wheat and a farm revenue insurance. Their relative performance has been compared at an equal cost.

3.2.1. the asymmetric risk management tools

(i) the put option on wheat price

Conceptually, the final value (FV) of the option per hectare is set as:

$$FV = S_i.r_{h,i}.\max[\delta_i.F_{0,i}(1) - F_{1,i}(1), 0]$$

with
S_i the acreage
$r_{t,i}$ the current yield per crop
δ_i the hedge ratio (delta) per crop
$F_{0,i}(1)$ the post crop November future price of wheat at planting period
$F_{1,i}(1)$ the post crop November future prices of wheat at crop period

(ii) the crop yield insurance on wheat

The insurance contract is described through its indemnity function. The indemnity function (IND) of the crop insurance contract is set as the following:

$$IND = S_i . \max [\lambda_i.r_{h,i} - r_{t,i}, 0]. F_0(1)$$

with
$r_{h,i}$ the historical yield per crop
$r_{t,i}$ the current yield per crop
λ_i the deductible rate of the contract per crop

Using the indemnity function, the pure premium value[4] of the contract is computed using a two stage Monte Carlo simulation. First the average cash-flow of the indemnity function is computed after 5.000 simulations. Then it is checked that an insurance constraint is fulfilled, such as the probability of indemnity payment (for instance, a maximum of 20 % of chance of payment, or one payment maximum every five years). This constraint is setting the minimum deductible rate of the insurance contract. If the constraint is fulfilled, the pure premium value is computed as the present value of the average cash-flow of the indemnity.

(iii) the revenue insurance per crop (wheat)

Indemnity is paid if the computed revenue at crop time is below a guaranteed level of revenue fixed per crop at the planting period. The indemnity function (IND) of the revenue insurance per crop is set as the following:

$$IND = \max S_i.[\lambda_i.F_{0,i}(1).r_{h,i} - F_{1,i}(1).r_{t,i}, 0]$$

with λ_i the deductible rate of the contract per crop

(iv) the farm revenue insurance

Indemnity is paid if the computed farm revenue at crop time is below a guaranteed level of revenue fixed at the planting period. The indemnity function is the following:

[4] The pure premium value should be increased by the value of insurance costs and competitive margin for finding the market value of risk.

$$IND = Max\ [\lambda\ .\Sigma\ (F_{0,i}(1).r_{h,i}\ .S_i)\text{- }\Sigma\ (F_{1,i}(1).r_{0,i}\ .S_i)\ \ ,\ \ 0]$$

with λ the deductible level on total farm sales

3.2.2. The compared performance

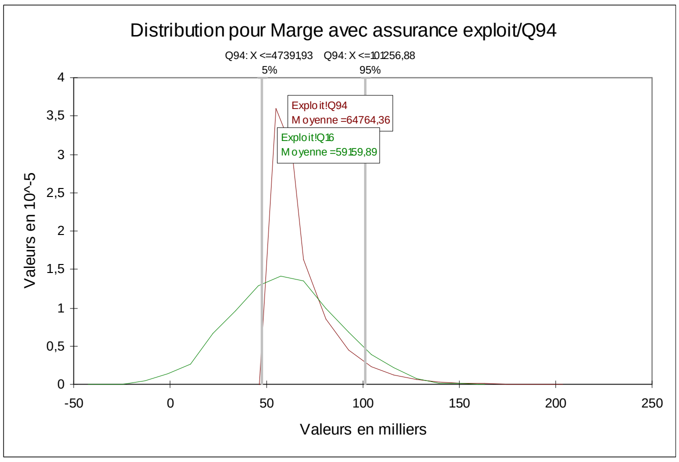
The performance of the tools (at equal pure premium cost) has been checked with respect to the coefficient of variation and VaR 5%. Table 11 presents the main findings for the scenario with high price-yield correlation and with single farm payment.

Table 11 : Distribution of farm margin with and without farm asymmetric risk management

	Estimated distribution	Mean	Standard deviation	Coefficient of variation	Skewness	Kurtosis	VaR5%
Initial margin	Normal	59.159	27.773	0,47	0,12	2,98	15.230
Using put option	Lognormal	65,770	22,825	0.35	1.42	6.83	28.790
Using crop insurance on wheat	Lognormal	63,653	26,977	0.42	0.19	3.37	15,343
Using sales insurance on wheat	LogLogistic Lognormal	65,003	15,109	0.23	1.13	5.57	44,695
Using insurance on whole farm sales	Exponential	64,764	15,280	0,23	1,96	3,37	47,391

The whole farm revenue insurance may then be considered as the most efficient tool. The deductible rate has then set at 13% for a 20 % of chance of indemnity payment to the farmer. Upon this constraint, the pure premium value of the insurance contract is estimated at about 100 € per hectare. This value is decreasing of course with the deductible rate. For instance, a 30% deductible rate brings the insurance premium to 35 € per hectare, which is a very low insurance premium. In other words, the probability for a farm to have a 30% loss in sales, which is the WTO rule for allowing public subsidies in the green box, is very low. The impact of the insurance contract on farm margin is illustrated in Figure 4.

Figure 4: Distribution of farm margin with gross sales insurance



2.3. Risk management between normal farm business risk and climatic/market shocks

Basically, the study performed on individual tools indicates that the major benefit of the symmetric management tool is the CV reduction when the major benefit of the asymmetric management tool is the VaR improvement. Therefore, optimization of use of the two types of tool cannot be a maximization (or minimization) of any parameter. The issue is more a feasible combined set of tools at a cost that the farmer is willing to pay, as illustrated in Figure 5 (Cordier 2004).

Figure 5: Mapping of the farm risk management tools

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The farm income risk management is simulated by (i) a precautionary saving provision and (ii) an insurance contract on total farm revenue. The method used is first applying the insurance contract in order to derive a series of farm margin, then smoothing the margin series on a VaR 40% pivot.

Based upon the stochastic farm margin model and optimal symmetric risk management using a precautionary saving provision as presented above, the study is looking at an optimal value of the insurance deductible rate.

Simulation has been performed under two extreme scenarios: the low risk scenario with high price-yield correlation and with single farm payment and the high risk scenario with low price-yield correlation and without single farm payment. Three deductible rates have been tested: 10, 20 and 30 %. The results are presented in table 12.

Table 12: Impact of combined tools (precautionary saving and farm revenue insurance)

Deductible rate	Low risk scenario		High risk scenario	
	CV	VaR 5%	CV	VaR 5%
10 %	0.18	49,347	0.31	12,520
20 %	0.21	37,281	0.44	7,872
30 %	0.34	18,633	0.84	-1,776

This type of results should be chosen by farmers with respect to the premium value of the insurance. The improvements in CV and VaR are not linear with respect to deductible rate. As the insurance premium is increasing when decreasing the deductible, an optimal level of deductible can be found with respect to individual risk aversion.

Conclusion :

Farm risk management is a rising issue of the Common Agricultural Policy. The 2003 CAP reform started to leave European farmers more directly exposed to market risk while climatic and sanitary risks are also rising. Futures and options contracts, insurance contracts, mutual funds and precautionary savings are now considered for farm income stabilisation in a global risk market. In addition, safety nets are asked by producers for crisis management.

The *pros and cons* of risk management tools are now well documented. The simulation of a stochastic farm income gives the opportunity to estimate farm risk within different scenarios of market environment. Basically, the price-yield correlation matrix between various crops has a significant impact on the farm risk level: about + 25-30% increase in the income coefficient of variation between a closed and open market environment. Furthermore, the single farm payment (SFP) as given to a grain farm in France in 2006-07 is also stabilizing farmer income. A 40-45% increase in the income coefficient of variation is expected if the single farm payment is suppressed.

The impact of a precautionary saving provision has been studied. A fixed pivot in relation with a high VaR value (40%) is more efficient than a moving average pivot (or exponential smoothing pivot). The performance analysis of asymmetric risk management tools was also studied. The analysis performed on four basic tools, price option, crop insurance, revenue insurance per crop and whole farm, is concluding in favour of the farm revenue insurance to improve the farm income value at risk. The theoretical diversification effect within the farm revenue improves the efficiency of this contract as compared with insurance contract on unitary risk. This contract should be targeted by public policy, in between any safety nets and fiscal measures in favor of precautionary savings (or mutual funds), whatever SFP are maintained or not.

This best performance of the farm revenue insurance is based upon pure premium. The capacity of the insurer to take advantage of the crop diversification effect should be studied as well as the related management costs.

Optimal coordination between savings for managing normal farm business risk and insurance against shocks has been checked practically. Sets of parameters have been found with respect to market environment and related risk. Additional work is required however for finding robust relationships between symmetric and asymmetric tools.

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