Direct payments, crop insurance and the volatility of farm income. Some evidence in France and in Italty

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Paper prepared for the 123rd EAAE Seminar

PRICE VOLATILITY AND FARM INCOME STABILISATION

Modelling Outcomes and Assessing Market and Policy Based Responses

Dublin, February 23-24, 2012

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Abstract

Volatility of farm income represents a major challenge for farm management and the design of public policies. This paper measures the extent to which risk management tools, especially direct payments and crop insurance, can significantly reduce crop income volatility in France and in Italy. We use an original dataset of 9,555 farms for the period 2003-2007 drawn up from the Farm Accountancy Data Network (FADN) and three different econometric models to explain the volatility of crop income. The results are contrasted between the specialization of the farms and the two countries: Italian farms use management tools (CAP payments and crop insurance) so as to improve their income and to reduce its volatility (crop insurance, inputs). French farms use the same instruments to increase their income and therefore its volatility while they tend to substitute CAP payments to production. These results question the efficiency of structural policies aimed at stabilizing the farmers' income.

Keywords: Volatility, Direct payments, Insurance, France, Italy, FADN

JEL classification: G22, Q14, Q18

1. Introduction

Due to the biological nature of agricultural production processes and their strong dependency on the natural and climatic conditions, since several decades in developed countries has been implemented forms of public intervention aimed at reducing income variability that have no parallel in other sectors of the economy. Without neglecting the peculiarities of the production conditions in agriculture, it is indubitable that agriculture in developed countries has reached high levels of complexity. Both the origins of income variability and its impact on the viability of farms have radically changed.

The organization of the agricultural production and its integration in the agro-food chain, the increased use by farmers of services such as credit, professional technical assistance, finance and insurance, the regulatory system within which it operates and the diversification of income are all factors that make the risk faced by today's farmers in developed economies something deeply different and more articulated than what it used to be only few decades ago.

In this scenario, we should also consider the impact of the greater future volatility of food markets upon the sector: climatic instability will translate into high crop yield variability, which will heighten tensions on the markets. As a result, the frequency of price shocks will increase, thereby increasing exposure to income risk for farmers and leading to farm closure (Capitanio, 2010). This eventuality is not only bound to squeeze farm yield potential, but also to favour conditions for a withdrawal of environmental and social conservation functions from huge tracts of rural areas and farmland world-wide. What has happened in the last few years is the demonstration that we are heading towards a scenario of greater uncertainties, which are inevitably reflected in market trends.

Farm income stabilization has traditionally been a great concern for European agricultural policy makers. Since the setting up of the Common Agricultural Policy (CAP), income stabilization was achieved mostly indirectly, through various price support mechanisms included in almost all Common Market Organizations (CMOs). With the gradual abandoning of price support that has followed the CAP reform process from Agenda 2000 on, the responsibility for smoothing up income fluctuations is being transferred more and more to the farmers or to Member States policy, although the introduction of the Single Payment Scheme (SPS), by providing farmers with a fixed amount, contributes to partly stabilize total farm income (Cafiero et al., 2007).

Traditional fruits and vegetables producers in the European Union (EU) have been excluded by price support measures that were typical of other CMOs, and therefore they could not benefit from the resulting income stabilization effect. Also, they have been initially excluded by the SPS (something that has changed with the latest reform). This eventuality could generate over the years remarkable differences in crop revenue volatility among farmers, in accordance with their specialization (e.g. cereals producers rather than wine).

In parallel with SPS, especially in Southern European countries (Italy, Spain and France), the income safety net provided by public policies has been strong, revolving around the functioning of Solidarity Funds and the release of payments to crop insurance. Mainly designed to compensate for income fluctuations due to the natural shocks which affect yields, these systems cannot be expected to provide effective protections against income fluctuations due to price instability. Nevertheless, they have likely been providing significant income stabilization over the years.

Since market stabilization was one of the founding objectives of the CAP, it may be argued that the increased volatility of market price could affect farmers' revenue both in terms of level and stability giving desirable a public intervention in supporting risk management policies in agriculture aimed to protect farmers' crop revenue either from price volatility and yield downfall.

Despite the stakes related to crop insurance and direct payments, few studies have been drawn on this topic till now. Both mechanisms provide a sort of certainty equivalent to farmers which should encourage them to continue their activity. The aim of this paper is therefore to measure the extent to which crop insurance and direct payments significantly reduce volatility in farmer's crop revenue in France and Italy, so that, which factors could explain crop income volatility in these two major countries of the EU.

To address this research topic, we focussed our analysis on crop income instead of farm revenue mainly for one reason. Since both crop insurance schemes and SPS are based on past physical farmers production, we argued that analysing the overall farm revenue could mislead the explanation of the empirical results. We do not underestimate that in several case there are different revenue activities in the farm (e.g. work outside the farm), which, among other things, negatively affect the farmers crop insurance demand, especially in Italy (Capitanio et al., 2011; Enjolras et al., 2012).

This study uses a survey data drawn up from Farm Accountancy Data Network (FADN) for farmers in France and Italy. We selected only farmers that had continuously belonged to the sample from 2003 to 2007. The sample included 2998 farmers for France and of 6557 for Italy. To our knowledge this is the first empirical analysis in this strand of literature that makes use of such large set of information in Europe.

To carry out our analysis, we used three econometric models aimed to capture, specifically, the return of income for farmers of both countries, using a balanced panel data; the increase/decrease of crop income, using a logistic model; the volatility of farmer's crop revenue, by use an Ordinary Least Square (OLS).

The structure of the paper is as follows. The next section provides a debate of the typologies of tools mainly used by farmers to manage their volatility. Section 3 introduces the empirical analysis, providing full details on the sample characteristics in terms of variables used and descriptive statistics and of the econometric models that we carried out. Section 4 presents the results and section 5 offers some concluding remarks.

2. A TYPOLOGY OF THE INSTRUMENTS AND TECHNIQUES FOR THE MANAGEMENT OF VOLATILITY IN AGRICULTURE

Over the years, many tools have been used for the management of risks in agriculture: starting from a diversification of the activities to the development of financial instruments. The aim of this section if to propose a typology that takes into account two dimensions in the use of these tools: their action on return and volatility of farmer's income and the timing of their use. This typology will provide a support to the choice of factors affecting return and volatility.

2.1. Return and volatility effects of the instruments and techniques

Following the usual distinction in finance theory, the farmer's yield is a random variable that can be described according to its return and volatility. Risk management aims at enhancing expected return while reducing volatility. As a result, we shall separate instruments which play a direct influence on yield level from those which aim at reducing its volatility.

As introduced, a well-known way to reduce volatility is to diversify activities. To do so, the farmer can use a three-stage plan (Wu, 1999). First, he chooses the repartition of his working time between the farm and external activities (Jetté-Nantel et al., 2010; Mishra and Goodwin, 1997; Poon and Weersink, 2011). Second, within the farm, he chooses his specialization: for instance breeding animals, crops or a mix. Third, within crops, he chooses his rotation, i.e. the number and variety of crops, by taking into account its capacities to irrigate some of them. By this way, the farmer is diversified before the season begins, which reduces the volatility of his yield.

Moreover, the farmer can complement the management of revenue volatility using insurance policies whose aim is to compensate physical losses due to natural disasters. Multi-peril crop insurance is now available in many developed countries, encompassing France and Italy (Enjolras et al., 2012). Basically, the insurance contract compensates crop yield losses providing the payment of an indemnity. Alternatively, crop-revenue insurance protects from deviations in the farmer's revenue. This type of contract is well developed in the United States whereas it is not widely spread in Europe. Some financial instruments also contribute to decrease yield volatility. Futures contracts allow the farmer to hedge price risk before the season and, recently, there was a huge growth of trading volumes in securities based on agricultural commodities, with the number of futures and options increasing five-fold between (Piot-Lepetit and M'Barek, 2011).

Some alternatives to financial markets exist that can help reducing volatility. Membership in a group of farms (legal form) provides a better market power for purchasing and selling commodities (Kyriakopoulos, 1997). Forward contracting guarantees the farmer to sell his crops at a price less dependent from market fluctuations (Velandia et al., 2009). Finally, the farmer use inputs such as pesticides to protect his yields against diseases and external attacks.

European payments, including SPS, are a way to increase substantially the return of the farm. Most of them are decoupled from production and linked to the rotation and to the area. As a result, they represent a guarantee in all circumstances. The farmer can also increase his return using inputs such as fertilizers which stimulate the development of the plants.

2.2. The timing of the instruments and techniques

The timing of use of each kind of tool is essential as it determines the strategy used by each farmer at the beginning of each season and the monitoring of this strategy during the season. Firstly, the farmer determines the basic structure of the production he will breed. At the same time, he chooses to insure his future production (Wu, 1999). He can also anticipate the amount of EU payments he will receive. A part of the structure of the farm is predetermined considering the situation over past seasons such as past investments and past payments.

During the season, the farmer is constrained by most of his initial choices but he can adapt his strategy taking into account external factors such as the climate or the commodity markets (Serra et al., 2005). Weather influences the use of inputs including pesticides which preserve yield against diseases while fertilizers contribute to increase crop yield (Babcock and Blackmer, 1994; Hall and Norgaard, 1974). The farmer can also decide spreading sales of its production according to the prices on the markets (Velandia et al., 2009). This adaptive management contributes to give the farmer some flexibility.

Table 1: Typology of risk management instruments and techniques in agriculture

		Timing	
		Strategy ***(Before the season)***	**Monitoring** ***(During the season)***
Direct influence on	**Return**	EU payments	Fertilizers
	Volatility	Specialization of activities Diversification of crop Irrigation Crop insurance Financial policies Forward contracting Legal form	Pesticides Spreading sales

Source: own elaboration

Table 1 shows the typology of risk management tools considering only the direct effects of the strategy and monitoring on the farmer's yield. It provides a dynamic overview of the farmer's capacities to manage his risk. Indirect effects, such as an additional wealth resulting from insurance claims, are random. As a result, they can only be accounted at the end of the season.

3. EMPIRICAL FRAMEWORK

3.1. The data

This study uses a survey of farmers in France and Italy belonging to the Farm Accountancy Data Network (FADN-RICA). This sample offers a reliable way to access to the structural and financial characteristics of professional farms, providing useful information about their balance sheet. It is then possible to identify strategies farmers use to cope with risk (Phimister et al., 2004).

Within the original databases, we selected only farms that had continuously belonged to the sample between 2003 and 2007. Our sample finally included 9,555 farms for each year among which 2,998 are French and 6,557 are Italian, representing a total of 47,775 observations over the period.

3.2. The variables

In the following subsections, we present the main variables that enter into the analysis. The detail is given in Table 2. We focus specifically on the ways to measure volatility and on the instruments used to hedge volatility.

3.2.1 Measure of farm income volatility

The reference used for the computations is income from crop production (y_i) because it provides the return specifically linked to this activity. It also avoids considering diversification resulting from activities outside the farm.

Following literature and public reports (Cordier et al., 2008; Dunn et al., 2000; OECD, 2000), we can consider two measures for volatility:

1. The growth rate (Δ_y) between each year, with $\Delta_y = (y_N - y_{N-1})/y_{N-1}$
2. The standard deviation (σ_y) over the period 2003 – 2007.

3.2.2 Instruments and techniques for risk management

Our models include many risk management tools used by French and Italian farmers. The farmer first makes some structural choices and he can choose the rotation. By doing so, he diversifies his activities and he reduces variance of his income (Purdy et al., 1997). Regarding his selection of cultures, he can forecast to irrigate part of his area so as to protect plant growth in case of drought (Dalton et al., 2004).

Farmers can also consider the sum of European payments they received. Their amount corresponds to a direct wealth effect (Hennessy, 1998; Sckokai and Moro, 2006). Payments effect may be ambivalent. On the one hand, the farmer can use them to invest and increase his production capacity. Thus, he might increase his income and the risk he takes. On the other hand, the farmer can use this additional money as a substitute to his activity. In that case, crop income and risk may decrease.

Insurance is another key indicator. We take into account the farmer's decision to insure or not, i.e. to subscribe policies sold by private insurance companies. Insurance decision may be costly depending on the amount of premiums (Enjolras and Sentis, 2011). Additionally to that criterion, we measure insurance profitability that is the difference between claims and premiums. A positive amount should be linked to a lower volatility (Coble and Knight, 2002).

The farmer can also use inputs, such as pesticides and fertilizers for the protection and/or development of his crops (Horowitz and Lichtenberg, 1994). Pesticides should reduce income volatility while fertilizers should increase the returns.

The FADN-RICA database does not provide access to some strategies used by farmers such as forward and future contracting or spreading sells. This appears as one of the limitations of the database.

3.2.3 Structural and financial characteristics of the farm

The extent of the surface, either measured by the total area or the area under cultivation, plays a direct role in the determination of the return. One can also expect that larger farms are more able to diversify their crops than smaller ones (Penrose, 1959).

Even if farms cultivate many crops, most of them are specialized. We can therefore make some distinction between particular productions considering the Economic and Technical Orientation (OTE). We differentiate 5 main OTE: field crop, wine-growing production, garden market, herbivorous breeding and other productions so as to identify different behaviours among the sectors (Cordier et al., 2008).

Farms can belong to a group so as to make economies of scale and increase their bargaining power (Marcus and Frederick, 1994). This strategy should lead to a better return and a lower volatility.

Finally, we consider an essential parameter of the financial situation of the farm, which is the debt level measured by the financial leverage or debt-to-assets ratio. Leveraged farms are exposed to a higher probability of default. As a result, they might adopt a more cautious strategy (Purdy et al., 1997).

3.2.4 Control variables

Weather plays a direct role in crop income volatility (Chmielewski and Kohn, 1999). Annual temperature and precipitations are measured for each year and considered at a location level. We then take into account the original values observed each year and their absolute deviations to the mean to measure their impact on return and volatility.

Some farms are located in less-favoured areas which correspond to high altitudes, steep terrain or economically depressed regions. Due to those constraints, their gain should be lower and their volatility higher.

We choose to introduce a dummy for each year. These indicators should reveal a systematic component of yield variation among farmers. Finally, we take into account the farmer's age. We use two measures: age and age-squared so as to control for an experience effect of the farmer.

3.2.5 Standardization of the data

As the size of the farm may have influence on the level of return and volatility (σ or Δ), it appears necessary to control its influence on other variables. Therefore, most variables of the models are standardized, by dividing them by the total area.

All variables identified above could not be considered in the models because of endogeneity. We can identify a strategic behaviour considering irrigated area, specialization, crop diversification and insurance which are simultaneously chosen by the farmer to reduce risk before the season. This behaviour has an impact on both these variables and crop income, which is our dependent variable. Because of the interaction between exogenous variables, we decided to consider only variable related to insurance. In fact, insurance is chosen at the beginning of the season while crop income is observed at the end.

Table 2: List of variables and summary statistics

			France		Italy	
		Classes	**N**	**%**	**N**	**%**
OTE	Economic and Technical Orientation 1 = Field crops, 2 = Wine-growing, 3 = Garden market, 4 = Herbivorous, 5 = Others	1	3982	33,2%	6387	24,4%
		2	798	6,7%	2466	9,4%
		3	166	1,4%	2022	7,7%
		4	3682	30,7%	5764	22,0%
		5	3364	28,1%	9589	36,6%
LFA	Less Favoured Area = 1 if farm is located in a less-favoured area, 0 otherwise	1	4748	39,6%	10164	38,8%
		0	7244	60,4%	16064	61,2%
Education	Education of the farm manager (3 categories: higher, secondary and other)	1	3979	33,2%	8856	33,8%
		2	6351	53,0%	13768	52,5%
		3	1662	13,9%	3604	13,7%
Legal form	Legal Form = 1 if farm is an individual farm, 0 otherwise	1	5700	47,5%	12388	47,2%
		0	6292	52,5%	13840	52,8%
Insured	Insured during the year (yes / no)	1	5953	49,6%	3259	12,4%
		0	6039	50,4%	22969	87,6%
Growth rate (dichotomous)	Δ = 1 if growth rate of crop income is positive, 0 otherwise	1	6469	53,9%	13494	51,4%
		0	5523	46,1%	12734	48,6%

Source: own elaboration, FADN 2003-2007.

Table 2: List of variables and summary statistics (continued)

	France	Italy
Number of observations per year	2998	6557
Number of observations (total)	11992	26228

Dependent variables

		Unit	France Mean	France Standard deviation	Italy Mean	Italy Standard deviation
Crop income	Level of crop income	€/ha	1564.80	6959.477	7868.07	251702.4
Δ of Crop income	Growth rate of crop income	%	53.805	5288.024	10.749	91.417
σ of Crop income	Standard deviation of crop income		20410.78	30510.17	7471.451	37835.32

Explanatory variables

		Unit	France Mean	France Standard deviation	Italy Mean	Italy Standard deviation
EU payments	European payments	€/ha	292.47	416.612	2837.9	178392
Δ of EU payments	Growth rate of EU payments	%	20.285	171.705	20.276	387.354
σ of EU payments	Standard deviation of EU payments		74.085	380.908	2335.131	122286
Insurance profitability	Total claims - Total premiums	€/ha	-2.755	152.990	-86.751	12776.770
Δ of Insurance profitability	Growth rate of insurance profitability	%	-6.490	3595.870	-23.150	3859.080
σ of Insurance profitability	Standard deviation of insurance profitability		34.213	128.3315	209.704	13198.570
Pesticides	Total pesticide costs	€/ha	147.119	250.148	258.844	867.688
Fertilisers	Total fertiliser costs	€/ha	140.234	402.460	300.315	1448.812
Inputs	Total input costs	€/ha	287.354	531.889	559.159	2135.747
Crop diversification	Number of cultivated crops	Nb/ha	0.109	0.132	0.563	3.592
Total area	Total area of the farm	ha	111.032	77.909	36.662	79.787
Turnover	Annual turnover of the farm	€	225268	168446	139628	429636
Financial leverage	Indebtedness of the farm		0.537	7.110	0.607	3.973
Average temperature	Average temperature observed over one year	°C	11.977	1.430	14.863	1.778
Temperature deviation	Deviation between the average temperature observed over one year and its average (absolute value)	°C	0.520	0.182	0.617	0.195
Aggregate precipitations	Aggregate volume of precipitations over one year	mm	724.311	189.907	684.047	390.400
Precipitations deviation	Deviation between the precipitations observed over one year and their average (absolute value)	mm	9.094	3.876	10.325	3.878
Age	Age of the farm manager	year	47.576	8.356	54.692	13.712

Source: own elaboration, FADN 2003-2007.

3.3. The models

Using our dataset, we develop three kinds of models that aim at measuring the influence of farm structure on crop income return, on its volatility and the growth of farm return over the period. All analyses have been performed for the two countries, France and Italy, to highlight their specificities.

We group our main variables into items regarding their influence on crop return: (1) risk management instruments (EU payments and insurance), (2) structural and financial characteristics of the farm and (3) control variables. The measure of the variables considered for each of these items may be different from a model to another. More precisely, the construction of variables on items 1 and 2 can change. This point will be discussed while presenting the models and the dependent variables.

3.2.1 Relation between income return and risk management instruments

To measure the impact of management factors on crop income return, we have considered the whole period, from 2003 to 2007. More precisely, we performed a panel analysis with random effect, on balanced panel data, to consider both individual and temporal effect. In fact, because our sample is not exhaustive, we chose to perform a random effect model (Nerlove, 2003 and Trognon, 2003). Moreover, the size of the sample and the existence of a location effect confirm this choice. We carried out heteroscedasticity and autocorrelation tests (Wooldridge, 2002).

As the model explains the level of crop income per hectare[1], some exogenous variables are considered in level. The model considered is the following:

$$y_{it} = \alpha + \beta' R_{it} + \gamma' S_{it} + \delta' C_{it} + \varepsilon_{it}$$

Where: y_{it} is crop income per hectare, α is the constant, R_{it} is the matrix of risk management instruments, S_{it} is the matrix of structural and financial characteristics of the farm, C_{it} are control variables and ε_{it} are error terms.

3.2.2 Relation between income variability and risk management instruments

The second model is a discrete regression model. The aim is to understand factors that lead to a positive growth rate of crop income. We distinguish positive and negative growth rates that are calculated as the variability of crop income observed for each farm between 2 years (Δ). Because of the dichotomous format of the dependent variable, we performed a logit model. The reason is the closer approximation between the logistic distribution and the standard normal distribution (Amemiya, 1981; Maddala, 1989).

[1] 1 hectare (denoted ha) is equal to 2,47 acres.

The latent variable Δy_i is continuous. The estimated model measures the impact of factors that make the income increase between 2004 and 2007 is the following:

$$\Delta y_i = \alpha + \beta'\Delta R_i + \gamma' S_i + \delta' C_i + \varepsilon_i$$

Where: Δy_i denotes a growth in crop income per hectare, α is the constant, ΔR_i is the matrix of the variability of risk management instruments, S_i is the matrix of structural and financial characteristics of the farm, C_i are control variables and ε_i are error terms.

3.2.3 Relation between income volatility and risk management instruments

The third model considers the volatility of crop income. Variables identified for item 1 and item 2 are now considered in terms of volatility over the period 2003-2007 (σ). More precisely, we defined the logarithm of this volatility for the dependent variable. In fact, we observed that the variance of the income increases with the income. The log-transformation is then used to stabilize the variance (Heij et al., 2004).

$$Log(\sigma_{yi}) = \alpha + \beta'\sigma_{Ri} + \gamma' S_i + \delta' C_i + \varepsilon_i$$

Where: σ_{yi} denotes the volatility of crop income per hectare, α is the constant, σ_{Ri} is the matrix of the volatility of risk management instruments, S_i is the matrix of structural and financial characteristics of the farm, C_i are control variables and ε_i are error terms.

4. THE RESULTS

In this section, we interpret the results of the models detailed above for French and Italian farms.

4.1. Summary statistics

Summary statistics are given in Table 2. Farms present rather different characteristics depending on their country. In Italy, their size is smaller than in France both in terms of total area and turnover[2]. They cumulate more risk management instruments and techniques (crop diversification, EU payments, pesticides and fertilizers). This leads to a more important crop income compared to France, which is less volatile over the period 2003-2007. It may signify that risk management is successful in Italy.

[2] Farms are considered as professional if their gross standard margin is higher than 4,800 € in Italy and 9,600 € in France.

Conversely, French farms are bigger but they benefit from a less favourable crop income per hectare, probably as a result of a decreasing marginal productivity. In line with a lesser use of management tools, they exhibit a higher volatility of their return. However, they benefit from a significant growth rate of their income. Thus, taking risk appears to be a winning strategy over the period.

One must also notice that indebtedness is similar among the countries while insurance is not profitable, especially for Italian farms.

4.2. Relation between income return and risk management instruments

The panel-data analysis explains the level of crop income per hectare by the main factors we identified in the previous section. The results are summarized in Table 3.

We observed that EU payments benefit to Italian farms as they are considered as an additional income. It seems to be the contrary for French farmers which seem to substitute subsidies and production.

The same relationship exists with insurance that leads to a higher crop income per hectare in Italy: this could be explained by a strategic behaviour aiming at securing the production. Insurance profitability (i.e. the difference between claims and premiums) has a negative impact on crop income in both countries, which means insurance is not profitable to farmers.

Considering inputs, the model highlights a positive impact on crop income for both France and Italy. In theory fertilisers should increase crop income while pesticides should reduce its volatility. Results show that both fertilisers and pesticides lead to increase crop income.

Farm's structure plays a role on the level of crop income in France, but not in Italy. For French farms, total area and crop income are negatively linked but there is a threshold above which the effect is opposite. This refers to decreasing returns.

Climatic constraints do not seem to affect the Italian crop income while French farms appear to be more sensitive in terms of both precipitation and temperature changes. Thus, a higher temperature leads to a lower crop income per hectare.

Beyond these effects, the model highlights specific features of some productions. In France, wine-growing is associated to a higher crop income while it is the contrary for market garden production[3]. In Italy, results show that market garden production is associated to a higher level of crop income.

The last difference between French and Italian farms is the temporal effect. In Italy, it seems that farmers keep the same crop income per hectare over the years, while this crop income appears to be more volatile in France.

[3] Site of the French Agricultural Ministry: http://agreste.agriculture.gouv.fr/definitions/otex-mbs/

Table 3: Panel-data regressions explaining crop income return.

	France	**Italy**
European payments	-1.415***	0.915***
Insured	-10.663	9403.352**
Insurance profitability	-2.320***	-5.830***
Fertilisers	9.468***	4.378***
Pesticides	6.949***	5.117***
Total area	-18.696***	-42.450
Total area^2	0.036***	0.044
Financial leverage	-3.148	-89.050
Legal form	-7.676	-3140.163
Age	-43.280	195.941
Age^2	0.576	-2.170
Education	110.711	-2572.622
Temperature	-279.597***	-703.720
Temperature deviation	-129.287	2517.014
Precipitations	0.242	-0.153
Precipitations deviation	20.376*	-169.312
Wine-growing	1882.917***	-634.905
Market garden	-2809.840***	11034.050*
Herbivorous	63.783	-838.981
Other OTE	427.493**	3203.739
Less-favoured areas	-130.114	833.004
2004	266.667***	-517.814
2005	-134.367*	-1057.152
2006	354.702***	1432.911
Intercept	4308.545**	13217.340
R^2 overall	0.565	0.702
Number of cases	11992	26228

Legend: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: own elaboration, FADN 2003-2007.

4.3. Relation between income variability and risk management instruments

While the previous model explains the level of crop income per hectare, this second one attempts to identify and evaluate factors leading to positive growth rate of crop income. The growth rate (Δ) is computed for each farm and between each period. Then we classify the farms according to its sign. The results are summarized in Table 4.

The results show that turnover has a positive effect on the probability of having a positive growth rate of crop income for Italian farmers while it has no effect for French farmers. In France, we observe that an increase of the growth rate of EU payments per hectare has a negative effect on the probability considered. It sounds going hand in hand with the results observed in the first model that highlighted the negative relationship between the amount per hectare of EU payments and the level of crop income. EU payments appear again to be a substitute to crop production in France.

Regarding insurance, the first model indicates that French insured farmers did not benefit from a higher return. However, the second model proves they have a higher probability to increase their crop income over time. The situation is opposite in Italy where insured farmers benefit from a higher income but the growth of this income is as stable as for non-insured farmers.

Considering inputs, we confirm the results observed previously in France and in Italy. An increase in fertilisers' expenses goes hand in hand with a higher probability to increase crop income. A differentiated effect is observed when charges in pesticides increase. For French farms, this leads to a higher probability of obtaining a positive growth rate of crop income, while the effect is opposite for Italian farms. This reveals strong differences in pesticide use between the two countries: French farmers apply them as a way to boost their production while Italian farmers use them to reduce their risk.

The model also emphasizes the sensitivity of French farmers to climate deviations. There also exist some production specificities. For instance, market garden producers have lower probability to obtain a positive growth rate of crop income if they are in France.

Being located in a less-favoured area leads to a lower probability of income growth in France whereas it does not lead to a lower level of crop income. In Italy, such a location does not seem to play a role neither on the level of crop income nor on the probability of having a higher growth.

Table 4: Logistic regressions explaining a positive growth rate of crop income.

	France	Italy
European payments	0.000	-0.000
Δ of European payments	-0.001**	0.000
Insured	0.258***	-0.042
Δ of Insurance profitability	-0.000	-0.000
Fertilisers	0.000*	0.000*
Pesticides	0.000	-0.000***
Crop diversification	-0.017	0.003
Total area	0.005***	-0.001**
Total area^2	-0.000***	0.000
Turnover	0.000	0.000***
Financial leverage	-0.003	-0.004
Legal form	0.054	-0.001
Age	0.006	-0.002
Age^2	-0.000	0.000
Education	-0.013	0.000
Temperature	-0.030	0.004
Temperature deviation	1.056***	-0.082
Precipitations	-0.000	0.000
Precipitations deviation	-0.018**	-0.004
Wine-growing	-0.015	-0.054
Market garden	-0.809***	-0.004
Herbivorous	-0.634***	-0.075
Other OTE	0.016	-0.099**
Less-favoured area	-0.475***	-0.019
2004	1.117***	-0.585***
2005	-0.764***	0.059
2006	0.095	0.676***
Intercept	-0.002	0.192

Correctly classified	0.691	0.621
Number of cases	11992	26228

Legend: * p < 0.05, ** p < 0.01, *** p < 0.001
Source: own elaboration, FADN 2003-2007.

4.4. Relation between income volatility and risk management instruments

The third model brings a vision complementary to the two first models. It focuses on the volatility of crop income, explained as the standard deviation of its return (σ) over the period 2003-2007. The results are summarized in Table 5.

The results demonstrate similarities between France and Italy. More volatile EU payments lead to increased crop income volatility. This emphasizes the close link between changes in EU support and the risk associated to the farmer's income.

Being insured increases the volatility of crop income in both countries, suggesting a moral hazard effect. We also notice that the volatility of insurance profitability has a positive effect on French crop income volatility while the opposite effect is observed in Italy. This means that insurance is not a stabilizing instrument in France while it reduces income risk in Italy.

Some structural aspects are common to French and Italian farms: belonging to a group of farms (legal form) allows to reduce the volatility of crop income. The area plays an ambivalent role: for small farms, the higher the size, the higher volatility while, for larger farms, the higher the size, the lower the volatility level. The volatility of crop income also depends from the location. Both in France and in Italy, farms located in a less-favoured area have less volatile returns than the others ones.

Weather conditions are a natural source of crop income volatility, in France and in Italy: the higher the temperature, the higher the volatility. In France, we also notice that higher precipitations lead to a lower volatility while the opposite effect is noticed in Italy.

We finally observe a temporal effect in France. The production also leads to differentiated effect according to the type of operated production. Wine growing brings less volatility than market garden production or field crop in France. We do not find such effects in Italy.

Table 5: Linear regressions explaining the volatility of crop income.

	France	Italy
European payments	0.000***	0.000
σ of European payments	0.000**	0.000***
European payments * LFA	-0.000	-0.000
Insured	0.098***	0.353***
σ of Insurance profitability	0.001***	-0.000**
Fertilisers	0.000*	0.000***
Pesticides	0.001***	0.000**
Total area	0.006***	0.012***
Total area^2	-0.001***	-0.001***
Turnover	0.000***	0.000***
Financial leverage	-0.001	-0.006
Legal form	-0.089***	-0.163***
Age	-0.010	-0.002
Age^2	0.000	-0.000
Education	0.004	0.037*
Temperature	0.055***	0.022**
Temperature deviation	0.136**	-0.958***
Precipitations	-0.000**	0.000***
Precipitations deviation	-0.001	0.051***
Wine-growing	-1.559***	-0.041
Market garden	0.805***	0.039
Herbivorous	-1.210***	0.224***
Other OTE	-0.542***	0.029
Less-favoured area (LFA)	-0.241***	-0.934***
2004	-0.107***	0.010
2005	-0.003	-0.007
2006	-0.082***	0.036
Intercept	8.485***	6.698***
R^2	0.602	0.218
Number of cases	2998	6557

Legend: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: own elaboration, FADN 2003-2007.

5. CONCLUSION

Despite the relevance and topicality of agricultural income volatility in the European Union, few studies have been drawn on the possible role of risk management tools until now. The principal aim of this paper was to measure the extent to which direct payments and crop insurance could significantly reduce crop income volatility in two major countries of the EU, France and Italy. This paper also intended to understand which factors could explain crop income volatility.

To address these research topics, we set up a typology of risk management tools taking into account their objective in terms of return and volatility. We then used an original dataset drawn up from the Farm Accountancy Data Network (FADN) for farmers in France and Italy from 2003 to 2007. To carry out our analysis, we used several econometric models so as to figure out the main dimensions and the dynamics of crop income volatility.

The results are contrasted between the two countries, which reflect differences in exposure to volatility and risk management practices. Italian farms are smaller than French farm and therefore more exposed to changes of their income. As a result, they use a large set of tools so as to increase their income (EU payments, crop insurance) and reduce its volatility (crop insurance, inputs). Despite some differences depending on the specialization of the farms, it appears that these tools manage to stabilize crop income over the years.

French farms exhibit a different behaviour. As their size is larger than in Italy, they tend to use direct payments as a substitute to crop production. It also appears that instruments supposed to reduce volatility (crop insurance, inputs) play in fact a risk-enhancing role. As a result, volatility is much higher than in Italy and it varies over the years. However this strategy appears to be beneficial over the period.

Variables related to the farm manager (age, education) and to the financial situation of the farm (leverage) are not significant, revealing that volatility mainly depends on the production conditions of the farm. In addition to EU payments and insurance, climate and specialization play a significant role in crop income volatility. For instance, wine growing brings less volatility than other crops in France.

These results question the efficiency of structural policies aimed at stabilizing the farmers' income as they may lead to an opposite effect. Hence, it would be of interest to confirm their validity for a larger scope of time. Taking into account annual data also restricts the scope of the analysis to the balance sheet of the farm. An access to additional variables such as the detail of production (prices and quantities) could offer a more precise analysis of crop income volatility. An alternative would be to estimate models designed for each farm specialization. Further research should address these issues in light of the current CAP reform.

ACKNOWLEDGEMENTS

This research was conducted within the framework of the Précovision project aimed at creating an advocacy tool intended to help reduce inputs in agriculture.

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