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Full Research Article

The instability of farm income. Empirical evidences on aggregation bias and heterogeneity among farm groups

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Abstract. This paper analyses the instability of farm income experienced by a constant sample of Italian farms over the period 2003-2012. It assesses the extent of the aggregation bias due to the use of aggregated vs. single farm data and estimates the level of farm income variability in several groups of farms for the whole period and for two sub-periods. Differences between groups and periods are assessed by means of non-parametric tests.

Results suggest that analyses based on aggregated farm data are likely going to strongly underestimate the extent of income variability faced by farmers. Income variability levels differ among farm groups and have significantly increased over the considered time. This has policy implications regarding the risk management tools recently introduced within the Rural Development Policies and how these should be targeted on the farms that more need them.

Keywords. Farm income, income instability and variability, aggregation bias, farm heterogeneity, risk management policies

JEL codes. Q12, G320, Q18

1. Introduction

Farming is a risky business because forces (such as weather) beyond the control of farmers affect their income (Mishra and Sandretto, 2002). Farm income stability has been one of the goals of agricultural policies both in the US and the EU (Mishra and Sandretto, 2002: 209). This is because income instability negatively affects farmers' well-being and decisions, their ability to expand operations and repay debt and, in turns, this can also have secondary effects on agribusiness firms and creditors (Mishra and El-Osta, 2001; Mishra and Holtausen, 2002; Mishra and Sandretto, 2002; Vrolijk and Poppe, 2008; Vrolijk *et al.*, 2009).

While a large number of studies focuses on price and/or yield and revenue instability (looking often at single crops or very specialised farms), there are not many analyses specifically focused on the stability of the whole farm income. This seems an important

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knowledge gap because "*… farmers are ultimately concerned more about their net incomes than about prices and costs*" (Mishra and Sandretto, 2002: 219). The lack of empirical evidences on income instability in the EU may become a constraint for monitoring and designing the set of tools that have been introduced by the recently reformed Common Agricultural Policy (CAP) to support farmers to cope with risk (Matthews, 2010; Meuwissen *et al.*, 2011; Tangermann, 2010)[1].

This paper tries to fill this gap investigating the level of income variability of a large constant sample of Italian farms over the period 2003-2012. This allows to assess the level of farm income variability in the whole considered sample and in several farms grouped according to production orientation, size and economic performances as well as of two consecutive periods of time.

The paper aims at identifying the information that are useful for designing and targeting income stability policy tools focusing on two aspects. On the one hand, it assesses whether it is preferable to use variability indexes that account only for down-side risk (i.e. movements of farm income on the left side of the distribution) (Horcher, 2005) or common variability indexes considering both sides of the distribution. On the other hand, the paper assesses how important it is to account for the heterogeneity existing within the farm sector. This issue is relevant because of two main reasons. First, as it is well known, focusing on regional or national aggregates is expected to generate aggregation bias that underestimates the level of variability experienced by farmers (Coble *et al.*, 2007). This aspect is relevant also to correctly assess the extent of the compensations of income losses that the recently introduced CAP income stabilization tool will pay to farmers. This is especially because it is still not very clear how the reference income and deviations from it will be assessed provided the existing heterogeneity in data availability and quality among EU Member States. Second, because farms strongly differ in terms of several dimensions, different farm groups can face different levels, types and evolution of variability.

The paper contributes to the existing literature because, based on our current knowledge, empirical evidences based on individual farm income data on the use of down-side risk indicators, on the extent of the aggregation bias and on whether income variability has increased over time are scant in the agricultural economics literature. Furthermore, the analysis is innovative because, to test for differences in terms of income variability between farm groups and periods, it uses non-parametric approaches that are less affected than parametric tests by the presence of outliers – a situation that is often encountered when using individual farm data.

The results of the analysis could also feed the policy debate regarding whether the instability of farm income is a relevant policy concern and the introduction of the new CAP risk management measures is justified. The analysis also provides insights on how to target intervention on the farm groups where it is more needed.

The next section casts the analysis into the previous literature on farm income variability while the following one describes data and methodology. Section 4 presents the

[1] Regulation (EU) No 1305/2013 of the European Parliament and of the Council of 17 December 2013 (O.J.E.U. L 347 of the 20.12.2013) establishes risk management measures that cover: (a) financial contributions to premiums for farm insurances (Art. 37); (b) financial contributions to mutual funds (Art. 38); (c) an income stabilisation tool, in the form of financial contributions to mutual funds, providing compensation to farmers for a severe drop in their income (Art. 39).

obtained empirical results while the last paragraph critically discusses the main findings of the analysis, underlines its weaknesses and identifies possible areas for further research.

2. Literature review on farm income instability

Several risks affect farm businesses but most of the analyses focus on the business risk that is generated by the aggregate effect of production, market and other sources of business specific risks (Hardaker *et al.*, 2007). While many analyses have been focused on single farm risk sources (e.g. yield risk or price risk) or single production enterprises (e.g. milk production), what is relevant is the interaction among the many elements generating business risk (OECD, 2009). This is because the overall risk a farmer is facing depends on the interactions among the different production activities carried on-farm and on the evolution of different parameters (e.g. product prices and yields). Furthermore, in the EU, farm incomes are supported by mean of direct payments that represent around 30% of farm income (European Commission, 2011) and have been claimed to reduce income variability (Agrosynergie, 2011; Cafiero *et al.*, 2007; El Benni *et al.*, 2012).

These elements support the idea that, to evaluate the business risk a farmer is facing, it is needed to account for the variability of the overall income of his/her farm over time (Mishra and Sandretto, 2002; OECD, 2009). In almost all the agricultural economic literature, analyses on farm risk refer to income (Agrosynergie, 2011; El Benni *et al.*, 2012; El Benni and Finger, 2013; European Commission, 2011; Finger and El Benni, 2014; Meuwissen *et al.*, 2008; OECD, 2003, 2009; Vrolijk and Poppe, 2008; Vrolijk *et al.*, 2009). However, the variability of the economic performances of firms can also be analysed by using cash flow indicators[2] (Plewa and Friedlob, 1995). Some Authors have supported the idea that cash flow can be used to do so because of two main reasons. First, cash flow is better observable and harder to manipulate under generally accepted accounting principles. Second, it is closer to liquidity management and can be a good indicator for the analysis of the firm's survival: a company that is short on cash could fail and be technically bankrupt despite it has a large amount of accounts receivable on its balance sheet. Despite this, cash flow has not been used yet in the agricultural economic literature apart in few cases (Meier, 2004). Because of this, we have decided to focus on farm income to allow for the comparability of the results with those of previous analyses.

In order to assess the level of instability farmers are facing, it is preferable to have farm-level time-series because the aggregation of data from different farms generates aggregation bias. At higher levels of aggregation, poor incomes in some farms are offset by good incomes in others thereby reducing the overall variability (Coble and Dismukes, 2008; Finger, 2012; OECD, 2009)[3]. Several Authors conclude that using aggregated data can severely underestimate the farm level risk (Coble *et al.*, 2007; Coble and Dismukes, 2008; Kimura *et al.*, 2010; Popp *et al.*, 2005). Despite this, empirical evidences on the extent of aggregation bias in the case of farm income variability are scant.

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[2] We thank one of the anonymous reviewers for suggesting us to consider this branch of literature. The use of cash flow seems a very promising and innovative direction for future research developments. In particular, it could be very interesting to compare income variability with cash flow variability.

[3] However, this phenomenon is reduced when systemic risk is pervasive and relevant.

This paper focuses on business related risks and considers only farm income. This seems coherent with the sectorial nature of CAP. However, other analyses, such as Mishra and Sandretto (2002), have investigated the instability of the income of farm households, i.e. considering also off-farm income. Mishra and Sandretto (2002) showed that the variability of the incomes of farm families has not diminished over the considered 7 decades. However, their analysis relies on national-wide data and does not provide evidences about differences within the sector[4]. Farm level analyses in the US focus more on the decomposition of household income variability by income sources than on the level of income variability *per se* (Mishra and El-Osta, 2001; Mishra *et al.*, 2002).

Empirical evidences based on single farm data are not abundant also in Europe. The analyses by Vrolijk and Poppe (2008) and Vrolijk *et al.* (2009) represent relevant pieces of literature on this issue. These rely on large samples of farms, have been developed in a considerable number of EU countries and allow for comparison between countries and types of farming. However, differences between countries and types of farms have not been subject to statistical testing. Finally, the focus in the EU is in most of the cases on farm business income (i.e. off-farm incomes are not considered) because of data availability constraints and the agricultural policy orientation of the analyses. However, this is not the case of recent analyses developed in Switzerland where the national farm data network also collects data on off-farm incomes (El Benni *et al.*, 2012; Finger and El Benni, 2014).

In order to assess and to manage risk, it has been found that, in some cases, it can be preferable to consider down-side risk other than common variability indexes (Miller and Leiblein, 1997). This is because farmers are generally more concerned with movements of farm income on the left side of the distribution (Horcher, 2005). However, indexes considering both sides of the distribution could perform equally well whenever, for example, the distribution of income over time is symmetric. Thus, the use of one type of variability index or the other should be chosen on the basis of the specific situation under study.

3. Data and methodology

3.1 Data

Having to assess the variability of farm economic results over the years, there is the need to select farms that have been in the samples for a reasonably long period of years. The analysis is based on data from all individual farms that belonged to the whole Italian sample of the Farm Accountancy Data Network (FADN) during all years of the decade 2003-2012. Thus, the dataset is made by a balanced panel because the considered farms do not change over the 10 years. These are 2404 farms for 24040 observations.

Referring to a constant sample of farms and the same time interval allows for better comparing results among farm groups and sub-periods because this avoids that some of the reported differences may be due to changes in farm composition[5]. The resulting num-

[4] Mishra and Sandretto (2002) use individual farm data in the second part of their paper to verify that off-farm income has contributed to the farm household income stability.

[5] The use of an unbalanced panel dataset, while increasing the number of observations, could generate comparability problems. This is because farms refer to time intervals of different length and to different periods (e.g. at the beginning or at the end of the interval of time).

ber of farms is large enough also for comparing groups of farms selected within the sample. This is important because the considered farms have been grouped according to types of farming, economic size and productivity level (European Commission, 2010) (Table 1). 7 types of farming (TF) have been considered to account for production orientation and specialisation. Economic size refers to small, medium and large farms defined by mean of the European Size Unit (ESU) classes provided by FADN. Finally, farms have been also classified into four groups according to the level of a partial productivity index calculated as the ratio between farm income and the amount of labour used on farm in terms of Annual Work Units (AWU) (European Commission, 2010).

Unfortunately, the choice to have only farms belonging to all considered 10 years has driven us to have a not randomly selected sub-sample. This has two important consequences. On the one hand, the selected sub-sample cannot be considered representative of the whole farm population. On the other hand, the statistical weights provided by FADN annually for each sampled farm cannot be used for reporting the results to the farm population. However, despite these limitations, it is important to note that the distribution of the farms within the sub-sample is very similar to the distribution of farms within the whole sample when grouped by types of farming, macro-regions and altimetry zones (Table A1 and A2 in the Appendix). The Finger and Kreinin (1979) similarity indexes computed on the two samples show a level of similarity that is never below 90%[6]. This suggests that the sub-sample does not provide an incomplete representation of the Italian farming sector.

3.2 Income definition and treatment of trends

The focus is on the FADN variable Farm Net Income (FI) that is the remuneration to fixed factors of production of the family (work, land and capital) and remuneration to the entrepreneur's risks (loss/profit) in the accounting year (European Commission, 2007). FADN is a business oriented database, thus it provides data on the income coming from the farming activities but it does not provide data on off-farm income earned by farm family members. However, it includes returns from nonfarm-based production activities such as, for example: hiring out of equipment, agro-tourism and forestry activities. FI is net of taxes linked to the farming activity but does not deduct personal taxes that are very much dependent on the overall amount of income (both on and off-farm) of the family members. The size of the FI depends, among others, on the relative amount of factors owned by the family provided that FI is net of the wage, rent and interest paid to third parties. Thus, if a farmer decides to use a large amount of external factors, this implies that (ceteris paribus) the remaining FI declines and, in some cases, it is likely that it becomes also more variable[7].

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[6] The Finger – Kreinin index has been originally developed to compare the structure of the export of products of two countries. It sums the shares of all products considering, for each product, the minimum value between the two series. Thus, it assumes a value of 100% in the case of complete similarity, while it tends to zero as long as similarity declines.

[7] The choice to use external factors is a management decision and farms indeed differ because they use different management strategies. The choice of obtaining labour, land and capital from third parties affects farm economic performances, their variability over time and, in turns, the wellbeing of farm families. Thus, it seems logical that different management strategies have different implications also in terms of the income risk farmers face.

As shown in the previous paragraph, farm income has been the economic variable used to assess the farm risk by almost all the analyses developed on the EU farm sector. This is because farm income describes better than other variables (e.g. revenues) the economic performances of a specific farm provided that, at the end, farmers are interested in how much the resources they use on-farm are remunerated and how this remuneration varies over time.

The fact that the mean or expected value of farm income has a trend or a cyclical behaviour does not necessarily imply risk: an economic variable may follow well-defined patterns that are known to farmers (OECD, 2009). Trends in income may occur because, for example, prices generally increase over time due to inflation and trends are pervasive in crop yields. For this reason, it has been chosen to eliminate the impact of inflation and to assess the variability around the trend (if existing). The original FI series have been first deflated by using the GDP deflator and later standardised (dividing each value by the 10 year average) to have all series centred around 1. The series have been then explored to identify linear trends by pooling all farms into 7 Types of Farming (TF) (i.e. farms with a similar production pattern) (European Commission, 2010) (Table 1). The trends have been estimated by using a robust regression approach based on two weight functions (Huber weights and bi-weights) to account for the presence of outliers (Finger and Hediger, 2008; Huber, 1964; Maronna *et al.*, 2006). Because in all types of farming but specialised granivore farms significant linear trends have been identified, the deflated FI series have been detrended in those 6 cases[8].

3.3 Variability indexes

The detrended series have been used to calculate two variability indexes in each farm. These are Standard Deviation (V1) and Semi-Standard Deviation (V2) of farm income over the decade[9]. For a generic i-th farm, this latter index has the following structure:

$$V2_i = \sqrt{\sum_{t_{FI_{i,t}<\overline{FI}_i}}^{T} \frac{\left(FI_{i,t} - \overline{FI}_i\right)^2}{m}} \tag{1}$$

[8] Because we worked with short time-series, it was considered not possible to get sound results from models able to explore the possible cyclical nature of the series. However, the use of linear trend appears still valid provided that estimation results are satisfactory. Furthermore, while the cyclical nature of price is very important, this is not necessarily the case for income series. This is because farm revenues come from different activities (i.e. diversified farms), they are also influenced by the evolution of unitary production levels (e.g. yields) and, in some cases, there is a natural hedge between the two (i.e. negative correlation between price and yield). Furthermore, incomes are also influenced by the evolution of production costs. In the considered decade, the prices of some commodities have shown some cyclical path (e.g. cereal prices higher than usual for two or three years) (Figure A1 in the Appendix). However, the examination of the evolution of farm income by types of farming does not provide evidences of clear cyclical behaviour (Table A3 in the Appendix). This is also the case of field crop farms because, in the same period in which cereal prices have been high, costs have also reached high levels due to the extraordinary high prices of some required inputs, noticeably, chemical fertilisers (Figure A2 in the Appendix).

[9] Standard Deviation has been calculated on standardized data, so it can be directly interpreted as a Coefficient of Variation of the absolute income. This allows for the direct comparability between farm groups and periods.

It differs from V1 because it considers only data from those years ($m < T$) in which income levels are below the average value $FI_{i,t} < \overline{FI}_i$ that, in our case, is calculated over the 10 year observations (T=10). Thus, this index focuses only on the down-side risk (i.e. adverse income conditions).

However, V1 could be a good proxy of V2 and has a very desirable property: it relies on a larger number of observations than V2. This latter aspect seems relevant in our case because only 10 years of data are available.

Variability indicators V1 and V2 have been obtained for each farm of the sample. The mean and median levels of variability have been analysed by grouping farms according to the three dimensions previously described: type of farming; economic size; farm productivity (Table 1). The disaggregation by types of farming is interesting because some production industries are inherently more risky than others and because diversification can reduce risk. Furthermore, the relative level of support provided by the CAP direct payments strongly differs in Italy among farms with different production patterns and economic size, and this source of income has been found to stabilise farm income (Cafiero *et al.,* 2007; El Benni *et al.,* 2012; Enjolras *et al.,* 2014; OECD, 2009; Severini and Tantari, 2013). Referring to productivity level is also relevant because the same relative level of income variability can have more severe implications for low productivity farms than for high productivity farms. This is because owned resources already receive a low remuneration and this generally implies a limited capability to accumulate cash reserves to cope with low income years.

The distributions of V1 and V2 within the groups and within the whole sample have been explored calculating common dispersion indexes (Standard Deviation and Coefficient of Variation) and testing for normality by means of the Shapiro-Francia test (Shapiro and Wilk, 1965). The results of these tests allow to reject the normality of the distributions. This has suggested to focus on median values (other than on mean values) of each considered group and to rely on non-parametric tests for comparisons among variability indexes, groups and periods.

Correlations between V1 and V2 have been calculated for the whole sample and for each group using the Spearman's test and the related *rho* correlation coefficient (Hauke and Kossowski, 2011).

Differences between farm groups have been tested by means of both Kruskal-Wallis test and Wilcoxon rank-sum test (Kruskal and Wallis, 1952; Mann and Whitney, 1947). The first allows to test for the presence of at least one inequality among groups. When the results of this test allow to reject the null hypothesis, the pairwise comparisons between groups has been developed by using Wilcoxon rank-sum tests. This latter has been also used to test for differences between variability indexes calculated in the periods 2003-2007 and 2008-2012.

3.4 Aggregation bias

In order to have a reference level to assess aggregation bias, V1 has been calculated not just on individual farm data but also on the average income of different groups of farms. The average income of the j-th group of farms (e.g. a specific type of farming) in the t-th year is:

$$AFI_{j,t} = \frac{\sum_{i_j}^{n_j} FI_{i,t}}{n_j} \tag{2}$$

where n_j is the number of farms belonging to the j-th group. The average over time of such aggregated income indicator is:

$$\overline{AFI}_j = \frac{1}{10}\sum_{t=1}^{10} AFI_{j,t} \tag{3}$$

Thus, when using the average income of the j-th group of farms[10], V1 is calculated as it follows:

$$V1_j = \sqrt{\sum_{t=1}^{10} \frac{\left(AFI_{j,t} - \overline{AFI}_j\right)^2}{10}} \tag{4}$$

The levels of variability calculated as in (4) are referred to as *Aggregated data* in Table 2. The other columns of Table 2 refer to basic statistics of the variability figures calculated on each individual farm of the sample.

4. Empirical results

While the median levels of standard deviation (V1) are higher than those of the semi-standard deviation (V2) (Table 1), the level of the two variability indicators are very much correlated. In all groups it is possible to reject the null hypothesis that V1 and V2 are not correlated according to the Spearman's test at 1% significance level. The *rho* correlation coefficient calculated on the whole sample is 0.889 and is greater than 0.79 in all groups (Table 1). These results allow to conclude that, the two indicators provide a very similar representation of the relative income risk of the considered individual farms. This supports the hypothesis that there is not an apparent advantage to rely on a down-side risk indicator (V2) in similar circumstances. Because of this, the presentation of the empirical results will focus on V1 only even because, as previously noted, V1 is calculated on a larger number of observations than V2.

The median of V1 for the total sample (0.637) suggests that farmers are faced with relatively high levels of income variability (Table 1). However, there is a high dispersion of V1 levels within each group as testified by the large values of standard deviation (SD) and coefficient of variation (CV) of V1 (Table 2). This is particularly the case of specialist field crop farms and, to a lesser extent, of specialist grazing livestock farms and specialist granivore farms (Table 2).

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[10] V1 has been also calculated on the average income of all farms of the sample (i.e. not just in each specific group of farms) by using the same approach. This figure is reported in row *Total sample* of column *Aggregated data* of Table 2.

Table 1. Sample size, median values and correlation between Standard Deviation (V1) and Semi-Standard Deviation (V2) of farm income within each group and the whole sample of farms.

		Sample size	Standard Deviation	Semi Standard Deviation	Correlation between V1 and V2:	
		Number	V1	V2	Spearman's rho^	
Types of Farming (TF)	**Code**					
Specialist field crops	1	572	0.659	0.534	0.911	***
Specialist horticulture	2	276	0.584	0.507	0.790	***
Specialist permanent crops	3	715	0.665	0.550	0.895	***
Specialist grazing livestock	4	493	0.572	0.484	0.887	***
Specialist granivore	5	84	0.844	0.739	0.796	***
Mixed cropping	6	161	0.688	0.564	0.879	***
Mixed livestock and Mixed crops-livestock	7	103	0.658	0.567	0.904	***
Economic size (ESU classes)						
Small (Classes 1, 2 and 3)		699	0.715	0.595	0.895	***
Medium (Classes 4, 5 and 6)		1595	0.604	0.509	0.887	***
Large (Classes 7 and 8)		110	0.686	0.589	0.828	***
Productivity levels (FI per unit of labour)						
Low		601	0.857	0.708	0.873	***
Low-Medium		601	0.642	0.530	0.880	***
Medium-High		601	0.549	0.479	0.880	***
High		601	0.545	0.457	0.867	***
Total sample		2404	0.637	0.530	0.889	***

^ In all groups it is possible to reject the null hypothesis that V1 and V2 are not correlated according to the Spearman's test at 1% significance level (***).
Source: Own elaborations on a constant sample of the whole Italian FADN farms for the period 2003-2012.

The comparison of the V1 calculated on individual farm data with those calculated on aggregated data allows to assess the extent of the potential aggregation bias. V1 calculated on aggregated data are always way lower than the medians of the values of V1 calculated on individual farm data. On the whole sample, the variability calculated on the aggregated data is less than ¼ of the median value of farm level variability (Table 2). Similar results are found even when the sample is subdivided according to types of farming: aggregation bias seems relatively lower for specialist field crop and for specialist granivore farms. However, in all cases the medians V1 calculated on aggregated data do not exceed 3/5 of those calculated on individual farm data (Table 2). This means that the extent of the aggregation bias is not substantially reduced even when farms are grouped according to their production specialisation.

Despite the large dispersion of variability within each farm group, it is possible to say that groups differ. Variability is lower in specialist grazing livestock farms (TF 4) and specialist horticulture farms (TF 2), while higher in specialist granivore farms (TF 5) (Table 2).

Table 2. Income variability levels (V1) by type of farming and in the whole sample. V1 has been calculated on aggregated data (i.e. sum of individual farm data) and on individual farm data.

		Aggregated data^	Individual farm data			
Types of Farming (TF):		V1	Mean	Median	SD^^	CV^^
Description	Code		of V1			
Specialist field crops	1	0.400	1.297	0.659	8.535	6.58
Specialist horticulture	2	0.091	0.689	0.584	0.479	0.69
Specialist permanent crops	3	0.120	0.909	0.665	1.523	1.67
Specialist grazing livestock	4	0.099	0.787	0.572	1.780	2.26
Specialist granivore	5	0.469	1.343	0.844	3.426	2.55
Mixed cropping	6	0.153	0.982	0.688	1.320	1.34
Mixed livestock and Mixed crops-livestock	7	0.233	1.111	0.658	1.699	1.53
Total sample		0.150	0.980	0.637	4.401	4.49

^ As specified in (4), figures in the column Aggregated data refer to the V1s calculated on the averages of the incomes of the farms belonging to each Type of farming as well as of all farms in the sample (Total sample).
^^ SD and CV of V1 should be considered with caution because V1 is not-normally distributed.
Source: Own elaborations on a constant sample of the whole Italian FADN farms for the period 2003-2012.

According to the Kruskal-Wallis test, there is at least one inequality among types of farming. The results of Wilcoxon rank sum test show that specialist granivore farms (TF 5) face a level of variability that is significantly higher than in the other groups. Specialist horticulture farms and specialist grazing livestock farms are in the opposite situation (Table 3).

The high variability found in specialised granivore farms is consistent with the findings of previous studies (Vrolijk and Poppe, 2008; Vrolijk *et al.*, 2009; European Commission, 2011) and can be explained by the nature of these farms: high specialisation and a limited importance of CAP direct payments. Similarly, the low income variability of specialist grazing farms is consistent with the findings of Vrolijk and Poppe (2008). On the contrary, the finding that also specialist horticulture farms are facing a relatively low level of income variability is not fully consistent with previous studies and contrasts with the common believe that horticulture crops are affected by high business risk. In this case, it is possible that diversification and other risk management tools already used by such farms (e.g. crop insurance) are effective tools to stabilise income.

Differences exist also among farms of different size. The median V1 in small farms is greater than in large farms and almost double than in medium farms (Table 4). This result is coherent with what has been found by the European Commission (2011). Despite the dispersion of values within the groups, Kruskal-Wallis tests suggest that there is at least one inequality among these groups. Furthermore, the Wilcoxon rank sum tests show that income variability of medium size farms is lower than that of the other two groups of farms with a statistical significance of 1%. This means that small farms are facing a relatively higher level of income variability. As suggested by Vrolijk and Poppe (2008), this could be caused by the fact that income of small farms is in many cases very low, so that

Table 3. Significance of the Wilcoxon rank sum test between couples of types of farming.

		Types of farming codes:						
Types of Farming (TF)	Code	1	2	3	4	5	6	7
Specialist field crops	1		***		***	***		
Specialist horticulture	2			***		***	***	*
Specialist permanent crops	3				***	***		
Specialist grazing livestock	4					***	***	**
Specialist granivore	5						***	***
Mixed cropping	6							
Mixed livestock and Mixed crops-livestock	7							

^ Significant at 1% (***), 5% (**) and 10% (*) according to Wilcoxon rank sum tests.
Source: Own elaborations on a constant sample of the whole Italian FADN farms for the period 2003-2012.

Table 4. Income variability levels by economic size classes and in the whole sample. Mean, Median, Standard Deviation and Coefficient of Variation of V1.

	ESU Classes	Sample size	Mean	Median	SD^	CV^	Wilcoxon rank sum test results^^:	
			of V1				Medium	Large
Small	1, 2 and 3	699	1.404	0.715	7.90	5.63	***	
Medium	4, 5 and 6	1595	0.789	0.604	1.06	1.35		**
Large	7 and 8	110	1.049	0.686	2.94	2.80		
Total sample		2404	0.980	0.637	4.40	4.49		

^ SD and CV values should be considered with caution because V1 is not-normally distributed.
^^ Significant at 1% (***), 5% (**) and 10% (*).
Source: Own elaborations on a constant sample of the whole Italian FADN farms for the period 2003-2012.

small changes in revenue (or costs) can cause high relative changes in income. However, despite that the median value is higher in small than in large farms, the results of the Wilcoxon test do not support the hypothesis that there are significant differences between these two groups of farms while it suggests that income is more stable in medium size farms than in the other two groups (Table 4)[11].

Income variability levels also differ among farms with different levels of productivity (i.e. farm income per unit of labour). The highest variability can be found in the low productivity farms (Table 5). Similarly, income variability in farms belonging to the next

[11] In very large farms most of the labour is provided by non-family members who receive salaries accounted for as explicit costs. This makes income of those farms relatively small if compared with the total revenues generated. Thus, also in this case, small changes in revenue (or costs) can cause high relative changes in income. The opposite can be said for medium size farms where a large share of the labour is often provided by family members.

Table 5. Income variability levels by classes of productivity levels (FI per unit of labour) and in the whole sample. Median and Coefficient of Variation (CV) of V1.

Productivity classes		Median of V1	CV of V1	Wilcoxon rank sum test results: 25-50%	50-75%	75-100%
Low	0 - 25%	0.857	5.01	***	***	***
Low-Medium	25-50%	0.642	1.34		***	***
Medium-High	50-75%	0.549	1.86			
High	75-100%	0.545	0.70			
Total sample		0.637	4.49			

^Significant at 1% (***), 5% (**) and 10% (*) according to Wilcoxon rank sum tests .
Source: Own elaborations on a constant sample of the whole Italian FADN farms for the period 2003-2012.

group (i.e. low-medium productivity) is significantly higher than in those belonging to the other half of the distribution (Table 5). The fact that the income is less stable in farms already facing productivity problems suggests that these farms are even more endangered by income variability than other farms. This is because a low level of productivity often results in the under-remuneration of farm resources and does not allow to accumulate cash reserves to be used in low income years.

Variability has increased over time. The medians of V1 calculated over the period 2008-2012 in the whole sample and in each farm group are always greater than those calculated in the previous period (2003-2007) (Table 6). This result is also supported by the analysis of the mean and the median values of V1 calculated over 6 overlapping sub-periods (Table 7). In both cases, there is a slight increase of the values of V1 moving from the first to the following periods, except for the last one.

The largest increment is found in specialist horticulture farms (TF 2). According with the results of the Wilcoxon rank sum tests, there are statistical significant differences between the two periods in all TF but specialist permanent crops farms (TF 3) that showed the lowest increase (Table 6). Significant increases can be found also in the three size groups. Large farms suffered the greatest increase, while small farms the lowest (Table 6). However, it is important to note that income variability increased the most in the farms with the highest levels of productivity while the less in those with the lowest levels of productivity (Table 6). This shows an improvement of the relative condition of low productivity farms.

5. Conclusions

The paper has provided empirical evidences regarding the five research issues described in the introduction. First, in the considered case, there is not an apparent and relevant advantage to account only for down-side risk to assess the relative level of income risk faced by farmers. This supports the hypothesis that simple variability indexes, such as SD and CV of farm income, could be used under similar circumstances. Second, a

Table 6. Variability levels in the periods 2003-2007 and 2008-2012 for the whole sample and for each farm group. Means and Medians of V1 and relative change over time of the Medians.

		2003-2007		2008-2012			Change in median values
		Mean	Median	Mean	Median		%
Types of Farming (TF)	**Code**						
Specialist field crops	1	1.270	0.515	0.948	0.582	***	13.0%
Specialist horticulture	2	0.424	0.302	0.719	0.565	***	87.2%
Specialist permanent crops	3	0.700	0.503	0.833	0.513		2.0%
Specialist grazing livestock	4	0.574	0.378	0.730	0.457	***	21.1%
Specialist granivore	5	0.817	0.515	1.450	0.648	**	25.7%
Mixed cropping	6	0.664	0.448	0.990	0.588	***	31.2%
Mixed livestock and Mixed crops-livestock	7	0.857	0.429	0.954	0.593	***	38.1%
Farm size classes (ESU classes)							
Small (Classes 1, 2 and 3)		1.198	0.531	1.160	0.585	***	10.1%
Medium (Classes 4, 5 and 6)		0.593	0.424	0.740	0.509	***	20.1%
Large (Classes 7 and 8)		0.983	0.438	0.768	0.549	**	25.4%
Productivity classes (FI per unit of labour)							
Low		1.454	0.665	1.422	0.701	***	5.4%
Low-Medium		0.649	0.465	0.802	0.524	**	12.5%
Medium-High		0.590	0.380	0.602	0.438	***	15.1%
High		0.452	0.354	0.627	0.485	***	36.8%
Total sample		0.786	0.449	0.863	0.531	***	18.1%

^ Significant at 1% (***), 5% (**) and 10% (*) according to Wilcoxon rank sum tests.
Source: Own elaborations on a constant sample of the whole Italian FADN farms for the period 2003-2012.

Table 7. Variability levels of income over the 6 sub-periods. Mean and median of V1 calculated on the whole sample.

	2003-2007	2004-2008	2005-2009	2006-2010	2007-2011	2008-2012
Mean	0.786	0.786	0.830	0.857	0.892	0.863
Median	0.449	0.505	0.539	0.559	0.571	0.531

Source: Own elaborations on a constant sample of the whole Italian FADN farms for the period 2003-2012.

large potential aggregation bias arises when using aggregated data. This confirms that it is preferable to use individual farm data to avoid underestimating the income risk farmers are facing. Third, Italian farms seem affected by a not negligible level of income variability and this is the case even if variability is calculated on deflated and de-trended series. Fourth, significant differences among farm groups have been found in terms of levels and evolution of income variability. This implies that not all farms face the same level of income risk and urge policies supporting their participation to risk management measures. In particular, income variability seems relatively lower in specialist horticulture and grazing livestock farms than in other types of farming. On the contrary, the analysis has confirmed that income variability is higher in small than in large farms. Farms with relatively lower productivity levels are affected by a relatively larger income variability. Fifth, results suggest that income variability has increased over the considered decade.

All these results have policy implications. The relevant aggregation bias and the differences within farms groups show that the recently introduced Income Stabilisation Tool correctly refers to the income of individual farms (i.e. does not rely on more aggregated data) for assessing income evolutions and the indemnities to be paid. The high and increasing level of income variability supports the idea that the introduction of risk management tools within the CAP toolbox could be justified. However, it is worth noting that income risk can be also coped by, for example, accumulating enough cash reserves or by integrating farm income with off-farm income. The differences among farm groups suggest that there is scope for targeting income stabilising policies on those farm types where income is more unstable and that are less able to manage income risk. Empirical results suggest that low productivity farms are likely those with the most pressing needs. These have been found to have a relatively high level of income variability and are very likely more vulnerable than farms with higher productivity levels even because are less able to accumulate large cash reserves (Mishra *et al.*, 2002).

Unfortunately, the analysis suffers from at least three main limitations that should be overcome in future analyses. First, the selected sub-sample cannot be considered representative of the whole farm population because it is not randomly selected. Furthermore, the results cannot be reported to the farm population based on representative weights. Therefore, sample statistics can differ from the population parameters. However, because the distribution of the farms within the sub-sample is very similar to the distribution of farms within the whole sample in terms of several dimensions, it is possible to say that the considered sub-sample does not provide an incomplete representation of the Italian farming sector. The second limitation is that, as previous studies on the same topic, it does not investigate the causes of the assessed income variability. Thus it seems important to develop future research to disentangle the role of different income components including CAP direct payments.

The third limitation is that, as in most of the analysis developed so far in the EU, the analysis accounts only for farm business income and this arises three main problems. First, a high variability of farm income does not necessarily imply an high farm household income variability provided that off-farm incomes have been found to stabilize the income of farm households (Mishra and Sandretto, 2002). Second, farmers can manage income instability by accumulating cash reserves to be used in low income years. Third, cash flow variability can be a different but promising way to look at the risk farmers are facing. These last three issues suggest that future analyses should enlarge the focus beyond what has been done in this paper by considering off-farm incomes (when data will become available), the availability and use of cash reserves and by comparing the variability of income with that of cash flow indicators.

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Appendix

Table A1. Comparison of the distributions of the farms in the considered sub-sample and in the whole FADN sample among geographical areas and altimetry zones.

	Sub-sample		Whole sample (2012)		Similarity^
	N. of farms	%	N. of farms	%	
Geographical areas:					90%
Center	343	14%	2098	19%	
Islands	171	7%	1172	10%	
South	626	26%	2903	26%	
Northwest	765	32%	2423	22%	
Northest	499	21%	2593	23%	
Whole country	2404	100%	11189	100%	
Altimetry zones:					98%
Hilly	1131	47%	5072	45%	
Mountain	478	20%	2326	21%	
Plan	795	33%	3791	34%	
Whole country	2404	100%	11189	100%	

^ Finger and Kreinin (1979) similarity index. 100% complete similarity.
Source: own elaboration on Italian FADN data.

Table A2. Comparison of the distributions of the farms in the sub-sample and in the whole FADN sample among types of farming and economic size.

		Sub-sample		Whole sample (2012)		Similarity^
		N. of farms	%	N. of farms	%	
Types of Farming (TF)	Code					93%
Specialist field crops	1	572	24%	3007	27%	
Specialist horticulture	2	276	11%	824	7%	
Specialist permanent crops	3	715	30%	3073	27%	
Specialist grazing livestock	4	493	21%	2504	22%	
Specialist granivore	5	84	3%	524	5%	
Mixed cropping	6	161	7%	691	6%	
Mixed livestock and Mixed crops-livestock	7	103	4%	566	5%	
Economic size (ESU classes)						98%
Small (Classes 1, 2 and 3)		699	29%	3100	28%	
Medium (Classes 4, 5, 6)		1595	66%	7311	65%	
Large (Classes 7 and 8)		110	5%	778	7%	
Whole farms		2404	100%	11189	100%	

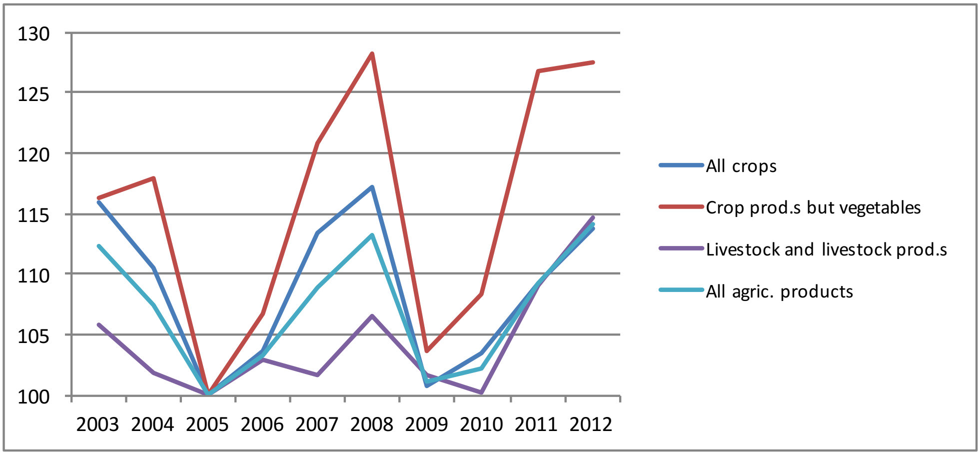
^ Finger and Kreinin (1979) similarity index. 100% complete similarity.
Source: own elaboration on Italian FADN data.

Table A3. Evolution of farm income level by types of farming in the analysed period (2003=100).

		Farm Income level (2003=100)									
		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Types of Farming (TF):	**TF**										
Specialist field crops	1	100	101	102	99	131	138	124	115	115	113
Specialist horticulture	2	100	97	96	99	100	108	103	101	95	73
Specialist permanent Crops	3	100	90	94	92	99	123	99	133	113	113
Specialist grazing livestock	4	100	87	90	109	107	114	104	109	112	105
Specialist granivore	5	100	137	104	79	74	66	88	76	56	74
Mixed cropping	6	100	96	91	98	140	114	123	140	145	128
Mixed livestock and Mixed crops-livestock	7	100	93	115	112	154	127	131	113	99	117
Total sample		100	99	97	98	106	112	105	110	103	101

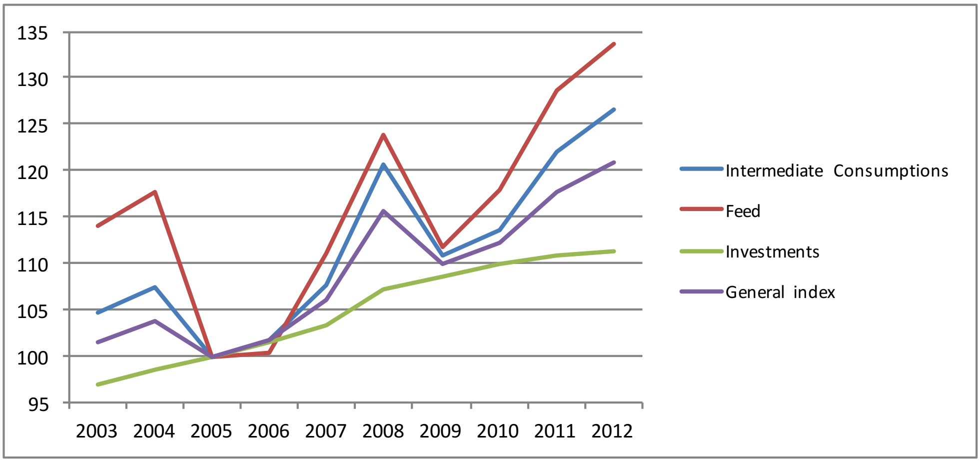
Source: own elaboration on Italian FADN data.

Figure A1. Evolution of agricultural product deflated price indexes in the years 2003 - 2012 (2005=100).



Source: Italian National Institute of Statistics (ISTAT); www.istat.it.

Figure A2. Evolution of agricultural input deflated price indexes in the period 2003 - 2012 (2005=100).



Source: Italian National Institute of Statistics (ISTAT); www.istat.it.