Rivista di Economia Agraria, Anno LXXI, n. 1 (Supplemento), 2016

The effect of agricultural policies and farm characteristics on income variability

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Abstract

This paper estimates how direct payments provided by the Common Agricultural Policy (CAP) affect variability of farm income over time. The analysis is based on robust regression estimations developed on a cross section database of a constant sample of 2402 Italian farms during the decade 2003-2012.
Results show that CAP direct payments allow for a reduction of the variability of farm income being less variable than other income sources. This suggests policy makers should support the continuation of such policy if income stabilisation is perceived as a relevant goal. However, regression results also provide evidences that structural immobility increases the variability of farm income while labour intensity does the opposite. This suggests that such goal could also be pursued by policies fostering farm structural change.

Keywords: Farm income, Common agricultural policy, Income stabilisation, Robust regression, Farm characteristics

JEL Classification Q12 · Q18 · G320

Introduction

Farm income stability has been one of the goals of agricultural policies both in the US and EU. A large share of the support provided to EU farmers by the Common Agricultural Policy (CAP) is delivered by means of Direct Payments (DP). These have been aimed at increasing and stabilizing farm income as well as supporting farmers to deliver a multiplicity of goods and services. Despite this, empirical evidences on the income stabilizing role of DP are limited.
The analysis focuses on the role of DP in stabilizing farm income in a large constant sample of Italian farms considering the period 2003-2012. The objective of the analysis is to answer

DOI: 10.13128/REA-18637
ISSN (print): 0035-6190
ISSN (online): 2281-1559

www.fupress.com/rea

whether DP reduce farm income variability also when other economic and structural farm characteristics are accounted for.

Farming is a risky business because forces beyond the control of farmers (such as weather) affect their income (Mishra and Sandretto, 2002). Indeed, variability of farm income far exceeds that of all households (Mishra et al., 2002). Stabilizing income is an important problem faced by farmers so that there has been a growing attention to cope with it (Mewissen et al., 2008; OECD, 2009). Farm income stability has been one of the goals of agricultural policies both in the US and EU because income instability affects farmers' well-being and decisions, their ability to expand operations and repay debt and, in turns, this can also have secondary negative effects on agribusiness firms and creditors (Mishra and Sandretto, 2002; Vrolijk and Poppe, 2008).

To assess the level of instability farmers are facing, it is preferred to work on farm-level time-series because aggregated data can severely underestimate farm level risk (Kimura, Antón, and LeThi, 2010; OECD, 2009). Empirical evidences support the idea that farm income variability is generally high even if differences between types of farms exist (Barry et al., 2000; El Benni, Finger and Mann, 2012; Vrolijk and Poppe, 2008).

Most of the support provided to EU farmers by the Common Agricultural Policy (CAP) is delivered by means of Direct Payments (DP) that account for around 77% of the Producer Support Estimate (PSE) provided by CAP (OECD, 2014). According to the European Commission (2010a), DP accounted for around 27% of the agricultural income of EU farms. DP have been found to play an income stabilizing role (El Benni, Finger, and Mann, 2012). This is because this source of income represents a fixed amount of income and it is not linked to market fluctuations being mostly decoupled from production.

Previous studies analyzed the role played by economic and structural variables in explaining variability of farm revenues and farm income (Barry et al., 2001, El Benni and Finger, 2013, El Benni et al., 2012). These studies discuss about the justification and the design of policy measures aimed at stabilizing farm income. In particular, the debate has been focused on whether the new structure of DP introduced by the recent reform addresses better than previous policies this goal and on whether additional and more focused instruments are needed (Matthews, 2010; Meuwissen et al., 2011; Tangermann, 2011).

Method

The analysis has been developed on the individual farms belonging to the whole Italian sample of the EU Farm Accounting Data Network (FADN) farms during all years of the period 2003-2012[1]. This has driven us to select a constant sample of 2,402 farms for 10 years (Table 1 and 2). Data has been analysed first by comparing income variability of the whole sample and within farms grouped according to: a) 7 Types of farming; b) Economic size classes (Small, medium and large); c) relative importance of DP (No DP and 4 quartiles). Unfortunately, the choice to have only farms belonging to all considered 10 years results in a

[1] Data have been obtained by the BDR database managed by the Istituto Nazionale di Economia Agraria of Rome (www.rica.inea.it).

not randomly selected sub-sample. This have two important consequences. On the one hand, the selected sub-sample cannot be considered strictly 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 1 and 2). The Finger and Kreinin (1979) similarity indexes computed on the two samples show a level of similarity that is never below 90%[2]. This suggests that the sub-sample does not provide an incomplete representation of the Italian farming sector.

Table 1. Comparison of the distributions of the farms in the considered sub-sample and in the whole FADN sample within geographical areas and altimetry zones.

	Sub-sample		Whole sample (2012)		Similarity^
	N. of farms	%	N. of farms	%	
Geographical areas:					90%
Center	343	14%	2,098	19%	
Islands	171	7%	1,172	10%	
South	626	26%	2,903	26%	
Northwest	763	32%	2,423	22%	
Northest	499	21%	2,593	23%	
Whole country	2,402	100%	11,189	100%	
Altimetry zones:					98%
Hilly	1,130	47%	5,072	45%	
Mountain	478	20%	2,326	21%	
Plan	794	33%	3,791	34%	
Whole country	2,402	100%	11,189	100%	

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

Table 2. Comparison of the distributions of the farms in the sub-sample and in the whole FADN sample within types of farming and economic size.

		Sub-sample		Whole sample (2012)		Similarity^
		N. of farms	%	N. of farms	%	93%
Types of Farming (TF)	Code					
Specialist field crops	1	571	24%	3,007	27%	
Specialist horticulture	2	276	11%	824	7%	
Specialist permanent crops	3	715	30%	3,073	27%	
Specialist grazing livestock	4	492	20%	2,504	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, 3)		697	29%	3,100	28%	
Medium (Classes 4, 5, 6)		1,595	66%	7,311	65%	

[2] 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.

Large (Classes 7 and 8)	110	5%	778	7%
Whole country	2,402	100%	11,189	100%

^ Finger and Kreinin (1979) similarity index. 100% complete similarity.

Source: own elaboration on Italian FADN data.

The focus is on farm income (FI) that represents 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, 2010b).

The variability of farm income is assessed by calculating Coefficients of Variations (CV) over the 10 year period in each farm (Table 3).

Table 3. Sample size, relative importance of direct payments (DP) and variability of farm income (FI). Mean values of PSE (DP/(REV+DP)) and DP/FI, median of CV(FI). Whole sample and groups of farms (REV=Value of sales). Years 2003 – 2012.

			Importance of DP^:				Variability	
		Sample size	PSE		DP/FI		CV(FI)	
		Number	Mean		Mean		Median	
Types of Farming (TF):	TF							
Specialist field crops	1	571	22.9%		80.9%		0.666	a b
Specialist horticulture	2	276	0.8%		2.0%		0.604	b c d
Specialist permanent crops	3	715	8.3%	b	25.5%	a	0.659	a b
Specialist grazing livestock	4	492	16.3%	a	45.5%	b	0.576	c d
Specialist granivore	5	84	5.7%	b	18.6%	a	0.725	a b
Mixed cropping	6	161	13.6%	a	44.7%	b	0.710	a b
Mixed livestock and Mixed crops-livestock	7	103	17.6%	a	60.6%		0.658	a b c
Economic size (ESU):								
Small (Classes 1, 2, 3)		697	14.6%		56.1%		0.734	a
Medium (Classes 4, 5, 6)		1,595	12.9%		37.5%	a	0.606	b
Large (Classes 7, 8)		110	9.3%		31.1%	a	0.619	b
PSE level^^:								
No DP	0	247	0.0%		0.0%		0.599	b c
Low	1st	540	2.0%		6.5%		0.667	a b
Low-Medium	2nd	539	8.1%		27.6%		0.629	a b c
Medium-High	3rd	537	16.4%		55.6%		0.661	a b
High	4th	539	32.4%		100.4%		0.617	a b c
Total sub-sample		2,402	13.2%		42.6%		0.636	

^Differences between groups statistically significant at 5%. ^^Tests regarding PSE and DP/FI have not been performed between groups of farms with different PSE levels.

Source: Own elaborations on Italian FADN data.

The role of DP on income stabilisation is analyzed by means of *robust regression* models accounting for other possible factors affecting income variability. Three main categories of variables have been explored: farm size, specialization, the farms' dependence on direct payments and off-farm income, liquidity and, finally, farms' location (Barry et al., 2001; El

Benni et al., 2012). In this analysis we analyzed the role played by the previous factors (except for off-farm income and farms' location) in explaining farm income variability.
As in previous studies (El Benni et al., 2012), we use the relative amount of DP over the whole farm receipts (revenues plus DP) to account for the role of DP. We name this index PSE borrowing this term from the Producer Subsidy Estimate estimated by OECD.
The estimated models took the following linear and quadratic forms:

$$CV(FI) = f(PSE, FCTC, FI, LABINT, SPEC1, SPEC2) \qquad (1)$$

$$CV(FI) = f(PSE2, FCTC, FI, LABINT, SPEC1, SPEC2) (2)$$

where:
CV(FI) = Coefficient of variation of farm income
PSE = Direct payments/(Revenues + Direct payments). In order to account for possible non-linearity, a quadratic model has also been estimated using the squared PSE (PSE2) in model (2).
FCTC = Fixed costs/Total costs
FI = Farm income
LABINT = Labor intensity, that is Utilized Labor units /Utilized Agricultural Area
SPEC1 and SPEC2 = dummy variables identifying three groups of farms differing in terms of specialization. These are: specialized crops farms, specialized livestock farms and mixed production farms.
A cross-section approach has been used to analyze the role played by each of the previous explanatory variables on the variability of farm income. Previous studies used a cross-section approach to determine which factors affect farm income risk. Barry et al. (2001) implemented a regression model using a cross-sectional data of 17-year mean values of the variables calculated on 213 farms from 1980 to 1996 (Barry et al., 2001). The analysis used an ordinary least squares (OLS) regression to determine whether farm income risk is influenced by structural farm characteristics. The poor econometric results of this first model suggested Barry et al. (2001) to shift to a panel regression approach with a moving three year coefficient of variation as the independent variable[3]. Similarly, El Benni et al. (2012) used a panel regression approach with 14 overlapping periods of 5 consecutive years each for the period 1992-2009: this leads to an unbalanced panel of 23,268 farms. This moving average kind approach enables to use as much information as possible regarding the income risk farms are facing. However, this approach relies on CV calculated on only 5-year period.
Our regression model is based on a constant cross-sectional dataset of 2,402 farms being constant over the period 2003-2012. Three are the major advantages deriving from using a cross-sectional approach. First, it relies on CV that are calculate on 10 year observation for each farm. This is important because, provided that some outliers can be found using farm level data, the CV calculated on shorter periods can be severely distorted. Indeed, comparing the CV calculated on 5-year periods shows that such estimated often strongly differ even when the 5-year periods are partially overlapping such as in the case of the CVs calculated

3 The CV is calculated each year (apart the first and the last years) considering data for three years. For year t, the CV is calculated considering the years t-1, t and t+1.

on the periods 2005-09 and 2007-11. Second, our analysis should overcome one of the limitation of the cross-sectional estimation implemented by Barry et al. (2001): the limited number of farms. Our analysis relies on a way larger number of farms allowing for the estimation of a not limited number of significant parameters.
Third, a cross sectional approach shouldn't be affected by serial autocorrelation bias, as in the case of overlapping periods. Thus, it does not require the corrections used in previous analysis to account for it (El Benni et al., 2012; Barry et al., 2001). Finally, because the presence of outliers and the fact that the independent variable PSE is not-normally distributed, OLS estimations have been proved to be not reliable also in our case. An OLS estimation with robust standard errors has been first implemented without solving the faced estimation problems. Finally, a robust regression approach has been used because this has been claimed to be more reliable under the specific circumstances (Maronna et al., 2006; Huber, 1981)[4].
The model has been first estimated on the whole sample. However, in a large number of farms belonging to the group of the Specialist horticulture farms PSE takes a zero value because these farms very often are not recipients of CAP Direct Payments. Thus, because the focus of our analysis is mainly on the role of DP, the model has been also estimated on a subset of farms given by the whole sample but specialist horticulture farms (i.e. 2126 farms).

Results

The level of support provided by DP is relevant accounting for around 13,2% of total farm receipts (PSE). However, there are relevant differences within the farm sample. Around 10% of the farms did not receive DP in the considered 10-year period and most of these belong to the group of Specialist horticulture farms. On the contrary, DP account for an extraordinary high share of income in Specialist field crop, in Mixed livestock and crops-livestock, Specialist grazing livestock and Mixed cropping farms. Similarly, the relative importance of DP is higher in small farms than in medium and large farms.
Variability of farm income over time is high. On the whole sample, the median coefficient of variation of farm income (CV of FI) is 0.64 and there are limited but significant differences between farm groups[5].
Variability is higher in specialist granivore, mixed cropping, specialist field crop, mixed livestock and crop-livestock as well as in specialist permanent crops farms. The high variability of Specialized granivore farms is consistent with the findings of Vrolijk and Poppe (2008) and can be explained by the nature of these farms: high specialisation and a limited

[4] Robust regression begins by fitting the regression, calculating Cook's D (a commonly used estimate of the influence of deleting a given observation when performing least squares regression analysis) and excluding any observation for which Cook's D>1. Thereafter it works iteratively: it performs a regression, calculates case weights from absolute residuals, and regresses again using those weights. Iterations stop when the maximum change in weights drops below a given tolerance level (Huber, 1981).
[5] Differences between groups have been statistically tested by means of Scheffe's and Wilcoxon rank-sum test.

importance of DP. Similarly, the low level of income variability of specialist grazing farms is consistent with the findings of previous analysis (Vrolijk and Poppe, 2008). Variability is also higher in small farms (Median CV is 0.73) than in medium and large farms as suggested by Vrolijk and Poppe (2008). On the contrary, there are only very limited differences between farms with different PSE levels in terms of income variability.

A correlation analysis between the independent variables has been performed and the degree of collinearity between all of them has been tested leading to a rejection of multicollinearity problems in the models. The coefficient of variation of farm income has a large range of variation around the mean. The presence of heteroschedasticity in the dependent variable has been detected and it leads to biased OLS coefficients of estimation[6], suggesting to use a robust regression approach. The relative importance of direct payments on farm receipts also varies within the sample. In particular, the distribution of PSE is truncated as it assumes zero value for a group of farms and is not normal. For this reason the robust regression model has been estimated both on the whole sample and on a subsample of 2126 farms (i.e. whole sample but horticulture farms). In the whole sample the estimated coefficient for PSE, even if negative, is not significant.

In the model estimated on the whole sample but horticulture specialized farms the estimated coefficient for PSE is significant and negative, as expected (Table 4). The impact of a change in the relative importance of direct payments on farm income variability is quite big, particularly if compared with results from previous studies (El Benni et al., 2012). As PSE exhibit a large amount of zero value and a possible non-linear effect on income variability, a quadratic model has been estimated both for the whole sample as for the whole sample but specialist horticulture farms, in which all the variables are kept constant except for PSE, that is substituted by its squared value. In both quadratic models, PSE is negative and significant, at 5% and 1% respectively in the whole sample model and in the subsample model. The other coefficients show very similar sign and magnitude than in the linear model.

Table 4. Results of the robust regression linear (1) and quadratic (2) models. Estimation results for the whole sample (WS) and whole sample but TF2 (WS-TF2).

	Linear models				Quadratic models			
	WS		WS-TF2		WS		WS-TF2	
PSE	-0.071		-0.187	***	-		-	
PSE2	-		-		-0.225	**	-0.363	***
FCTC	0.548	***	0.557	***	0.545	***	0.557	***
	-		-		-		-	
FI	0.00007		0.00008		0.00007		0.00007	
LABINT	-0.037	***	-0.186	***	-0.037	***	-0.164	***
SPEC1	0.028		0.044	*	0.029		0.043	*
SPEC2	-0.029	*	-0.044	**	-0.032	*	-0.045	***
Intercept	0.491	***	0.536	***	0.492	***	0.519	***
N. of obs.s	2,402		2,126		2,402		2,126	
F-stats	28.471	***	25.029	***	28.880	***	25.224	***

Source: Own elaboration on FADN data.

*Note: ***, ** and * indicate significance at 1%, 5% and 10%.*

[6] The presence of heteroschedsticity in the dependent variable (CV of FI) was tested through Breusch-Pagan / Cook-Weisberg test.

Both in the linear and quadratic models, the estimated coefficient for the ratio between fixed and total costs (FCTC) is large and positive: as expected, an increase of the structural immobility of the farm leads to an increase of the variability of farm income (Table 4). The relative intensity of Labor per unit of land (LABINT) is also found to reduce the variability of farm income provided that the estimated coefficient is negative and highly significant. This means that farms with a higher unitary intensity of Labor have less variable incomes than other farms. On the contrary, the estimated coefficient for farm income, even if negative, is not significant.

The estimated coefficients for the two dummy variables referring to farm production specialization (SPEC1 and SPEC2) are, respectively, positive and negative, even if only the estimated coefficient for SPEC2 is significant at 5%. This latter result means that mixed farms are less risky than livestock specialized farms.

This suggests that Specialized Livestock farms have less variable incomes than Specialized Crop farms. However, it is not very clear how much the level of income variability in Mixed farms differs from that of the other two considered groups. If we accept a 10% significance level for the coefficient of SPEC1, we can say that the variability of income in Mixed farms does not differ from that of Specialized crop farms. However, if we assume the coefficient of SPEC1 is not significantly different from zero, we can say that the variability of income in Mixed farms does not differ from that of Specialized livestock farms. Because we propend to accepting the second hypothesis, we believe that the variability of income in both Specialized livestock farms and Mixed farms is lower than that in Specialized crop farms.

The results of the analysis provide empirical evidences on the role of the current DP policy in terms of stabilizing farm income and on the need to redesign it to better cope with this goal. This, in turns, could foster the debate on whether the new structure of DP introduced by the recent reform will address it better than previous policies and, finally, on whether additional and more focused instruments are needed (Matthews, 2010; Meuwissen et al., 2011; Tangermann, 2011).

Conclusions

To summarize, the analysis suggests that the variability of farm income is influenced by several farm economic characteristics: the relative importance of direct payments, the relative intensity of labour per unit of land and the relative importance of fixed costs. The first two variables allow for a reduction of the variability of farm income while the latter one seems to have the opposite effect.

The most relevant policy result is that CAP DP have a stabilizing effect on farm income. This is because DP stabilize farm income even if the extent of such effect strongly depends on their relative importance. Indeed, there is a not negligible number of farms in Italy that has not received or has received only a limited amount of DP and, consequently, has not been affected by such policy. On the contrary, some types of farming have been very much dependent on DP.

While the analysis has shed lights on the factors affecting income variability, it is also important to underline some of its limitations that should be overcome in future research.

The first is that the analysis could be expanded accounting for more explanatory variables such as, for example, the relative importance of family labor. The second limitation is that our analysis only focuses on farm income and not on household income. While this is correct when the focus is on business risk, this is not enough when the objective is to analyze the implications of income variability on household welfare. This is particularly the case for small farms where off-farm income generally represents a large share of the whole household income.

As the analysis supports the hypothesis that DP stabilize farm income, it shows that DP pursue an additional policy relevant goal apart income support and redistribution. However, such role only depends from the fact that, as suggested by the results of the quadratic model, the stabilizing role of DP tends to increase as the relative importance of DP increases. This has a direct policy implications regarding the likely impact of the recently reformed DP policy. The introduced internal convergence of DP level (i.e. regionalized DP), that is expected to result in a more uniform level of DP per hectare among Italian farms, can generate an increase income variability in those farms that have received relatively higher DP levels. While the shift to a uniform DP level will be only partial and gradually implemented because of the application of the "Irish model" of internal convergence in Italy, this suggests policy makers to already consider measures to cope with this possible negative outcome. According to our results, two are the possible directions to follow: a reform of the DP policy and the use of new policy measures.

The analysis has shown that the stabilising role of DP mainly depends by the fact that DP are less variable than the other income components. This means that this policy could be better targeted to play an income stabilising role. In particular, if this is perceived as a relevant policy objective, together with the main goal of income redistribution and support, DP could be redesigned to play a countervailing role against fluctuations of farm revenues and costs similarly to the countercyclical payments used in the USA. This means that part of the DP a farm receives each year (e.g. the basic payment) should vary according to such fluctuations[7]. However, such a radical change in policy could cause a drastic redistribution of benefits among farmers and could make annual public expenses for DP less predictable and stable than under the current policy setting. Both elements are very binding constraints to changes in this direction.

However, the obtained results suggest that there are alternative rooms of manoeuvre to help EU farmers to better manage income risk. Because factors other than DP affect income variability, it should be considered to design policy measures aimed at fostering structural change and, in particular, to enhance those farms' characteristics that have been proven to be correlated with income variability such as reducing the relative importance of fixed costs. Rural development policies could be used to reach also this goal. Indeed, new measures within such policies have been introduced specifically to address farm risk management issues (Tangermann, 2011). As shown by the results of the analysis, it seems very likely that the reform of DP policy will make some farm typologies more affected by income variability and, thus, making some Italian farmers more willing to participate into these new measures.

[7] It does not seem reasonable to apply this approach to the green payment, provided that this is aimed at compensating farmers for the provision of public goods and services.

This suggests policy makers to make such measures available within the Member States where they operate and to design these in a way to allow a large number of farms to participate.

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