The direct and indirect effect of CAP support on farm income enhancement: 
a farm-based econometric analysis

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Abstract:

We assess the correlation between CAP support provided to farmers and their income and use of capital and labour in the first year of the new CAP regime. This is done applying three regression models on the Italian FADN farms controlling for other farm characteristics. CAP annual payments are positively correlated with farm income and capital but are negatively correlated with labour use. Farm investment support provided by RDP measures is positively correlated to the amount of capital. Results suggest that CAP is positively affecting farm income directly but also indirectly by supporting the substitution of labour with capital.

Keywords: Common Agricultural Policy, Farm income, Farm capital and labour, Policy Evaluation.

1. Introduction

The agricultural sector is described by the literature as affected by the so called “farm problem” (Gardner, 1992), i.e. a situation of low and unstable incomes (Schultz, 1945) and low rates of return on farm resources. That causes disparity between the incomes of farm and nonfarm households (Katchova, 2008).

The farm problem has been empirically studied by a large body of literature (see, for Italian examples, Boncinelli et al., 2017; Boncinelli and Casini, 2014). It is identified by two conditions: limited amount of resources and, in particular, limited endowment of capital, and low rate of return on farm assets. This is the classical motivation for public policies providing farm income support, among several other goals (Gardner, 1992).

The CAP supports significantly EU farmers, via a large set of different measures (Ciliberti and Frascarelli, 2015; Grant, 2010). Most of the support provided by direct payments (e.g. BPS and SAPS) as well as annual payments from the EU RDP measures such as agro-environmental or LFA payments. All these annual payments have a direct enhancing effect on the income of the year in which these are granted. However, all this support could also affect farmers decisions including the use of factors such as capital and labour. This is because some of the support is coupled to production (i.e. VCS) but also because the overall support provide financial resources that could relax financial constraints and increase returns to farm investments. The resulting changes in factor use could also have an indirect impact on farm income.

The RDP support to farm investments is also expected to have some effects on the amount of capital available on farm (Esposti, 2007). This could have an indirect impact on farm income, by enhancing its economic performances. However, in contrast with annual payments, this is likely to occur not in the year in which this support is granted, but in the following years.

In this paper, we assess the correlation between CAP support and the income level, use of farm capital, and use of farm labour through three separated regression models. We accounted for the impact of CAP on the use of capital and labour because this can indirectly affect farm income level.
The analysis is developed on the Italian FADN farms in 2015, that is the first year of implementation of the new CAP. Regression models include as regressors different types of CAP measures and additional regressors that may affect income, capital and labour level. The results of the analysis are used to shed light on the complex role of CAP in supporting agricultural incomes, and, in particular, on both its potential direct and indirect effects.

In the next section a brief literature review is provided. Sections 3 and 4 present the methodology and data, respectively. Section 5 describes the results, while the last Section provides some conclusions and policy recommendations.

2. Literature review on the role of income enhancing policy support

Where income support is an objective, it is important that the policy pursues it in an efficient way. In general, empirical analyses have referred to the direct impact of the policy by estimating the ability of the considered policy to enhance the income level of agricultural households. This can be measured in terms of income transfer efficiency (OECD, 2002; Kilian and Salhofer, 2008). Three are the main sources of inefficiency: Targeting efficiency; Economic costs; Distributive leakages. Because of this, part of the support provided by agricultural policies (including direct payments) contributes to increasing the costs of resources, the income of input suppliers and the income of non farming landowners (OECD, 2002). According to this source: “no support policy linked to agricultural activity succeeds in delivering more than half the monetary transfer from consumers and taxpayers as additional income to farm households” (OECD, 2002: 10). However, the level of transfer efficiency and the destination of the money transfer differ according to the policy instrument. Decoupled direct payments (DDP) are generally expected to have a larger transfer efficiency than other forms of support because these do not affect farmers decisions and do not increase production costs (OECD, 2001). Coupled direct payments (CDP) also directly support farm income but, in order to receive such support, farmers have to alter their production choices. Similar considerations apply to RDP being granted conditional to the fulfillment of specific requirements. This may result in an increase of production costs that partially offset the net positive impact of support and reduce transfer efficiency.

Apart from the direct effect of public support to farm income, policy measure embed an indirect effect through its impact on the use of production factors, namely the asset, labor, and land (OECD, 1999). Indeed, policy reforms induce structural breaks in the agricultural system (i.e., changes in the amount of labor, assets, and investments) (Ellen et al., 2008). However, little has been said about the effect of policy on the latters, with lion share of works devoted to the U.S. agriculture, unveiling the need of a research effort by European agricultural economists (Moro and Sckokai, 2013). Using AgriPolis model Happe et al. (2008) studied structural changes in two German regions according to different policy scenarios, concluding that fully DDP decreases the shadow price of factor of productions, pushing farmers looking for alternative uses of labor and capital. Bojnec and Latruffe(2013), considering Slovenian farms, found negative correlation between technical efficiency and CAP subsidies, whereas a positive relationship exists when considering small farms’ profitability. O’Toole and Hennessy (2015) investigate how DP affects financial constraints in Irish agriculture, concluding it reduces financial restrictions, supporting farm investment. Bartolini and Viaggi (2013) simulated a scenario in which all CAP payments were abolished, to disentangle their effect on the allocation of factor of production, especially land. They find that different SPS has a significant effect on land demand, and that CAP abolition would reduce the farmed area. Kirchweger and Kantelhardt (2015) studied the impact of RDP on Austrain
milk farmers, concluding it increases the number of heads, and the UAA, especially for investing-farms. Brady et al. (2009) conclude SPS inflates land rental prices, reducing the ability of farm income security. Studying the effect of agricultural price policy on the U.K. agriculture, Traill (2008) found an increase in the former would positively impact investments and the net farm income, while negatively for labour and labour-earnings.

3. Methodology
The analysis is developed on the whole 2015 FADN Italian farms, accruing for the first implementation year of the new CAP. We divided CAP support into two broad groups:

- TAP: Total Annual Payments: this includes all types of direct payments (DP) and the annual payments provided by some Rural Development Policy measures (RDPa)
- RDPo: support not granted as annual payments (mostly farm investments) by other RDP measures.

This division is because while TAP directly influence farm income in the same year these are granted, this is not the case for RDPo. Because RDPo generally support farm investment, we assume that RDPo does not affect directly farm income in the year it is granted. However, it is assumed to affect the relative amount of factors, noticeably capital and labour.

The direct impact of policy support based on annual payments on farm income is represented in the following Figure 1. Farm income is measured as Farm Net Value Added per unit of labour to allow comparability among farms of very different size (Y/L). Farm income is clearly affected by other factors including the relative amount of capital, measured by the ratio capital per unit of labour (K/L), and the labour intensity measured by the amount of labour per unit of Utilised Agricultural Area (L/UAA) (The other factors are not represented in the figure.

![Figure 1](image)

Figure 1. Representation of the impact of the direct impact of policy support provided by annual payments (TAP) on farm income (Y/L) accounting for the role of farm capital (K/L) and labour (L/UAA). Source: Authors’ personal elaboration

However, it is not possible to say which policy measures can have such impact. However, it is foreseeable that RDPo play a relevant role in this regard as it supports farm modernization and investment decisions. Indirectly, a change in the farm assets could affect farm income level. Note that, given the nature of RDPo, this can have an impact on farm income level not only in the year it is granted, but also in the following periods.

CAP could also affect the amount of capital and labour. Both TAP and RDPo can have an impact on the relative amount of farm capital (K/L) and on labour use (L/UAA) as depicted in Figure 2 and 3.
Based on this way of reasoning, the econometric approach is based on the following 3 equations that mimic the relationships described in Figure 1, 2 and 3:

\[
\frac{Y_i}{L_i} = \alpha_0 + \alpha_1 TAP_i + \ldots + \alpha_n X_{ni} + \varepsilon_i
\]  
(1)

\[
\frac{K_i}{L_i} = \beta_0 + \beta_1 TAP_i + \beta_2 RDP_{0i} + \ldots + \beta_n Z_{ni} + \eta_i
\]  
(2)

\[
\frac{L_i}{UAA_i} = \gamma_0 + \gamma_1 TAP_i + \gamma_2 RDP_{0i} + \ldots + \gamma_n W_{ni} + \kappa_i
\]  
(3)

Where:

\( Y_{i} / L_{i} \) is farm income per unit of labour in the i-th farm, 
\( TAP_{i} \) is the total amount of annual payments, 
\( K_{i} / L_{i} \) is the available capital per unit of labor, 
\( RDP_{0i} \) is the sum of non-annual RDP support (e.g. support for farm investments) in the considered year plus the previous two years (i.e. 2015, 2014, 2013), 
\( L_{i} / UAA_{i} \) is labour intensity as amount of used labour per unit of Utilized Agricultural Area in the i-th farm, 
\( X_{ni}, Z_{ni}, W_{ni} \) are control variables used within the models.

All the variables referring to CAP support are divided by the labour input used on farm (i.e. Annual Work Units - AWU). The parameters of the three models are \( \alpha, \beta \) and \( \gamma \) while the error terms are \( \varepsilon_i, \eta_i \) and \( \kappa_i \).

The models have been estimated by means of Least Squared Dummy-Variable regression (LSDV) because of the inclusion of several dummy variables accounting for altimetry regions, types of farming and organic farms (Baltagi, 2001).

Because some of the variables are not normally distributed, we transformed these to improve normality or symmetry. However, because some of these variables in a few cases are negative (e.g.
farm income), we used the Yeo-Johnson (2000) approach other than the usual Box-Cox transformation (Baltagi, 2001).

4. Data
The analysis has been developed on a sample of Italian FADN farms in 2015. The sample included 9029 farms. However, 287 of these have been eliminated because having very limited levels of total amount of work and utilised agricultural land (UAA). In particular, farms having less than 0.1 AWU or less than 1 ha of UAA have been eliminated. This is because many of the variables considered in the models have these variables as denominators. Using farms with lower level makes the index very unstable. Finally, additional 546 observations have been eliminated because classified as outliers. This has been done by using as threshold four times the Cook’s distance (Baltagi, 2011; Fox, 1991). Therefore, presented results refer to 8196 observations that represent around 91% of the original sample.

Below a table providing a description of the variables used in the models and related descriptive statistics as well as the distribution of sampled farms among farm groups.

Table 1. Definition of the variables considered in the models and related descriptive statistics. Number of farms within types of farming (TF), altimetry regions and organic farms.

| Code | Description | Unit of Measurement | Mean   | SD    | Number   |
|------|-------------|---------------------|--------|-------|----------|
| TAP  | TAP Total Annual Paments (DP+RDPa) | Euro/AWU | 7,215 | 9,662 |          |
| RDPo | RDP farm support other than RDPa | Euro/AWU | 1,252 | 9,148 |          |
| Y/L  | Y/L Farm Net Value Added per unit of labour | Euro/AWU | 29,994 | 27,678 |          |
| K/L  | K/L Capital over Labour input | Euro/AWU | 1,562,838 | 236,829 |          |
| L/UAA| L/UAA Labour intensity | AWU/ha | 0.182 | 0.107 |          |
| SIZE | SIZE Farm Size | Euro x 1000 | 198 | 2,545 |          |
| SIZE²| SIZE² Farm Size Squared | Euro x 1000² | 6,517,893 | 415,184,926 |          |
| TF1  | TF1 Fieldcrops | Dummy (0; 1) | 2137 | | |
| TF2  | TF2 Horticulture | Dummy (0; 1) | 163 | | |
| TF3  | TF3 Wine | Dummy (0; 1) | 2612 | | |
| TF4  | TF4 Other permanent crops | Dummy (0; 1) | 1850 | | |
| TF5  | TF5 Milk | Dummy (0; 1) | 387 | | |
| TF6  | TF6 Other grazing livestock | Dummy (0; 1) | 544 | | |
| TF7  | TF7 Granivores | Dummy (0; 1) | 58 | | |
| TF8  | TF8 Mixed | Dummy (0; 1) | 445 | | |
| PLAIN| PLAIN Plain farms | Dummy (0; 1) | 1880 | | |
| HILL | HILL Hilly farms | Dummy (0; 1) | 3806 | | |
| MOUNT| MOUNT Mountain farms | Dummy (0; 1) | 2510 | | |
| COST | COST (Interm. Cons. and Depreciation)/Tot. Assets | % | 0.127 | 0.617 | |
| FAMLAB| FAMLAB Relative amount of family based labour | % | 0.854 | 0.237 | |
| UAA  | UAA Utilised Agricultural Area | ha | 29.4 | 38.5 | |
| ORGANIC| ORGANIC Organic farms | Dummy (0; 1) | 432 | | |

Source: Own elaboration on Italian FADN data.
5. Estimation results

The estimation results for Models 1, 2 and 3 are reported below (Table 2). As it is often the case in cross-sectional analysis, the goodness of fit is not very good even if the F statistic is highly significant. Importantly, most of the estimated coefficients are significantly different than zero, allowing some policy considerations.

Table 2. Estimation results for the models 1, 2 and 3.

|                | Model 1 (Y/L) |                      | Model 2 (K/L) |                      | Model 3 (L/UAA) |
|----------------|--------------|----------------------|--------------|----------------------|-----------------|
|                | Estimate     | Std. Error           | Estimate     | Std. Error           | Estimate        |
| Intercept      | -3001.7      | 2710.1               | 1652455      | 15540 ***            | 0.347713        |
| SIZE           | 4.230        | 0.433 ***            | 12.006       | 3.834 **             | 0.000001        |
| SIZE           | -0.000024    | 0.000003 ***         | -0.000068    | 0.000023 **          | 0.000000        |
| FAMILAB        | -20403.8     | 1229.3 ***           | -25106.77    | 10877.277 *          | -0.047844       |
| UAA            | 113.6        | 9.3 ***              | 31.8         | 82.5                 | -0.001084       |
| L/UAA          | 10412.4      | 3945.9 **            | -543139.0    | 34409.9 ***          | Dependent variable |
| K/L            | 0.021        | 0.001 ***            | Dependent variable |                          | -0.00000000054 | 0.0000000003 ***
| RDPo           | Not included |                      |              |                      |                 |
| COST           | 4033.2       | 445.8 ***            | -111355.9    | 3748.8 ***           | -0.003697       |
| TAP            | 0.817        | 0.034 ***            | 4.148        | 0.301 ***            | -0.000003       |
| HILL           | 129.5        | 694.0                | -43639.2     | 6123.4 ***           | -0.021356       |
| HILL           | 4467.3       | 758.3 ***            | 36559.0      | 6701.4 ***           | -0.011158       |
| TF2            | 10040.7      | 2072.0 ***           | 85333.5      | 18316.4 ***          | 0.176016        |
| TF2            | 5744.5       | 799.0 ***            | 43454.1      | 7056.0 ***           | 0.063538        |
| TF2            | 5920.4       | 793.3 ***            | 14173.1      | 7021.7 *             | -0.000820       |
| TF2            | 17068.4      | 1484.5 ***           | 127814.4     | 13063.3 ***          | 0.052375        |
| TF2            | 2264.0       | 1153.6 *             | -19990.7     | 10210.4 .            | 0.025058        |
| TF2            | 3060.5       | 3136.2               | -27952.7     | 27758.3              | -0.006593       |
| TF2            | 933.9        | 1245.0               | 2481.7       | 11020.3              | 0.012237        |
| ORGANIC        | -2482.9      | 1196.4 *             | -54028.4     | 10577.0 ***          | -0.015064       |

\[R^2\] 0.2806 0.2302 0.6243
Adj \[R^2\] 0.279 0.2285 0.6235
Res. Std. Err. 23500 208000 0.06586
F Statistic\(^{\text{a}}\) 177.2 *** 135.8 *** 754.9 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 1 ' ' 1. \(^{\text{a}}\) df= 18; 8177.
Source: Own elaboration on Italian FADN data.

CAP annual payments (TAP) are positively correlated with income level (Model 1). Similarly, there is a positive correlation between the amount of capital (K/L) as well as labour intensity (L/UAA) and income level. The same is true for farm size, even if this positive correlation declines as long as farm size increases (i.e. a negative coefficient for \[\text{SIZE}^2\]). Some TF have a relatively higher income level than farms specialised in field crops (TF1). Similarly, organic farmers have a lower income level than the other farms.

Results of model 2 show a positive correlation between CAP support and the relative importance of capital (K/L). In particular, the support provided by annual payments (TAP) is very positively
correlated to the amount of capital. The RDP support other than annual payments that includes support to farm modernization (RDPo) is also positively correlated with capital but, surprisingly, it is significantly different from zero only at 5%. Farm size (SIZE) is positively correlated also with K/L. The relative level of capital differ according to farm specialization (TF) and the location of the farms, with hilly farms having lower levels than other farms.

Results of model 3 show a significant negative correlation between the TAP and labour intensity (L/UAA). On the contrary, RDPo are found to be not correlated with labour intensity. Also in this case, farm size play a role: labour intensity is positively correlated with farm size even if this correlation declines as long as farm size increases. Finally, there are differences among farms grouped by TF and located in different regions also in terms of labour intensity. Furthermore, organic farms are found to have a lower labour intensity than other farms.

6. Discussion and final considerations
The proposed regression models are a very simplified approach to analyse the role of CAP on farm income. Furthermore, the overall goodness of fit of the models is poor. Despite this, the coefficients estimated for the considered policy variables are generally significant providing some preliminary results that could be used to draw policy considerations.

However, it is important to stress that these coefficients only show that a correlation exists between policy variables and the dependent variables. However, because the models include several regressors other than those referring to CAP, the estimated coefficients for these latter variables should provide an estimate of the correlation by controlling for other factors that may affect farm income, capital and labour use.

The results suggest that the overall support provided by CAP could enhance farm income both directly and indirectly. While a positive correlation between TAP and farm income comes with no surprise, the results regarding the indirect role of CAP are less obvious. Both TAP and RDPo are found to be positively correlated with the relative amount of capital (K/L). Such phenomenon may be caused by the fact that such payments allow to relax the farm credit constraints. This could play a very positive role in terms of the goal of enhancing farm income, provided that the ratio K/L is positively correlated with farm income (Figure 4). Surprisingly, the results seem to suggest that TAP may be even more effective than RDPo in this regard.
Finally, TAP could also cause a reduction of labour intensity. In contrast with the previous finding, this could have the effect of reducing farm income.

Unfortunately, the current approach has a relevant limitation: it does not allow to identify the direction of the causative effect. While we plan to overcome this limitation in future research, we believe the results obtained so far show the potential usefulness of the approach. This is because the results allow to identify some hypotheses regarding the possible role of CAP to be tested in the near future.

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