# Does an income gap between farm and nonfarm households still exist? The case of the European Union

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## Abstract

The paper compares the income conditions of farm and nonfarm households in the whole EU and within three geographical groups of countries for the period 2008-2016. Overcoming the simple comparison of raw means of the groups, we estimate the farm/nonfarm income differentials by using Regression Adjusted and Covariate Matching techniques, which allow to control for observable characteristics among groups. Three innovative features of our analysis are that we account for the whole income of farm households (i.e. not only farm income), for the presence also of in-kind incomes from self-consumption of produced goods and imputed rents from properties and for the complex survey design.
We find that an income differential still exists but with relevant differences across countries and along the period. Most of it is due to differences in the households' characteristics. Hence, comparing raw means of the two groups can be misleading. Non-monetary sources of income play a not negligible role, improving the relative position of farm households. The role of agricultural and rural policy is discussed in the light of results.

Keywords: Agricultural Households, Income, Covariate Matching, EUSILC, European Union
JEL Classification codes:D31, I31, Q18

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## 1. INTRODUCTION

One of the main and traditional justifications for the policy support provided to the farm sector is the assumption that the income in agriculture is systematically lower than other production activities. Gardner (1992) refers to this as one of the main dimensions of the "farm income problem". He reviews the theoretical justifications of such an assumption and the empirical evidence provided to support it. He concludes that the evidence of the low level of farm income is weak, showing that a tendency toward convergence exists between farm and non-farm income levels in the USA. A similar trend has also been detected in the European Union (EU), even though results are sparse and not fully comparable (e.g. Stefani et al., 2012; de Frahan et al., 2018; Nordin and Höjgård, 2018). These results, if confirmed, should reorient the Government's role in the sector.

In the EU, while the Common Agricultural Policy (CAP) nowadays pursues a large set of objectives other than farm income enhancement, the income disparity remains one of the main justifications of important policy tools. One of the CAP's objectives reported in the Consolidated Version of the Treaty on the Functioning of the EU[1] is "…to ensure a fair standard of living for the agricultural community, in particular by the increasing of the individual earnings of persons engaged in agriculture".

While the emphasis of agricultural policies has been traditionally focused on income from farming activities, there has been a shift of debate from *farm* to *farmer* income in recent years. This is because the agricultural households often have additional sources of income

[1]Article 39 of the Official Journal of the European Union, C 326 of the 26.10.2012.

other than farming.[2] This calls for addressing the analysis on the total income of farm households rather than on income from farming only. Unfortunately, most of data on the farm income in the EU come from sector surveys, which oblige scholars to still focus their analysis on production units (holdings). For instance, building their results on data from the Farm Accountancy Data Network (FADN) survey, Espinosa and colleagues (2019) offer a very interesting EU-wide perspective but their analysis cannot go beyond farm incomes only. Among studies considering the total incomes of farm households, most analyses refer to US data (Mishra et al., 2002; Hopkins and Morehart, 2004; El-Osta et al., 2007; Katchova, 2008). The last comprehensive analysis for Europe refers to 2001 (Eurostat, 2003).[3] More recent research has been developed by De Frahen et al. (2018) who analyse OECD countries and Stefani et al. (2012) and Severini and Tantari (2014) who work with Italian data.

Among the above studies, some add relevant features to the analysis of the income differential. For instance, Katchova (2008) and Nordin and Höjgård (2018) control for relevant household characteristics (such as age). Beside, De Frahen et al. (2018) suggest that

[2]Mishra and Sandretto (2002) reported that 94% of farm households collect some type of non-farm income. Mishra et al. (2002) show that more than half of US farm operators were employed off-farm, and 80% of them held full-time jobs off-farm. Indeed, according to many authors, the level of inequality between farm and non-farm incomes has also declined because of farmers' decisions to supplement their income with off-farm work (e.g., Mishra and Goodwin, 1997; Mishra and Sandretto, 2002).

[3]In Europe, the last comparative analysis among EU countries relies on a diversity of data and estimation methodologies (Eurostat, 2003). According to Hill and Bradley (2015), "...the evidence points to farmers not being a particularly low-income sector of society in most Member States judged on the basis of their household disposable incomes".

on average low income is not a chronic problem among farm households in none of the ten surveyed OECD countries. However, they show that disparity exists among countries.

Consensus on the presence of a farm household income gap, however, cannot be easily achieved since different approaches and sources are used. De Frahen and colleagues (2018, p.126) also states: "When income comparisons do exist…they are sensitive to the sources of information, the methods of estimation, and the definitions of incomes and farm households versus non-farm households that are used".

Considering research discussed above as a starting point, the aim of this paper is to estimate the income differential among farm and non-farm households within the EU. This analysis adds to the previous literature in two ways. The first is that the income condition of EU farm and non-farm households is analyzed using a single, harmonized database. This is the European Union Statistics on Income and Living Conditions (EUSILC), a survey that collects information on income and the well-being of a representative sample of all European households. EUSILC, to the best of our knowledge, has not yet been used to investigate income conditions of farm households, neither on the whole EU level nor by considering single Member States or groups of countries.[4] Because of the differences in terms of income level and other characteristics, our study considers three groups of countries beside the whole EU: Central Eastern, Mediterranean and Western Continental EU countries. Although EUSILC would allow us to identify farm households in different ways according to the relevance of farm income on total household income (see United Nations, 2012 on possible classifications), we empirically estimate the income disparity between "narrow" farm households, for which farming represents the main source of income, and non-farm households living mainly on income coming from self-employment activities. This

[4]The only exception is the analysis for Italy proposed by Rocchi (2014).

comparison allows isolating what could be defined as a "pure" sector effect. In facts, both groups are involved in self-employed activities but in different sectors of the economy.

Differently from previous studies, the information available in EUSILC survey allows also to consider an extended measure of households income, including also non-monetary sources of income such as dwelling on farm and self-consumption of produced goods.

A further contribution of the present article is from a methodological perspective: the empirical analysis relies on approaches that are currently used in the literature on income analysis outside the specific field of agriculture,. Starting from a simple comparison of average income levels, we move to Regression Adjusted (RA) methods (following Katchova, 2008) and then to Covariate Matching (CM), two techniques based on a "counterfactual" logic.

The findings of the present study allow policy considerations that could fuel the debate on how to redesign farm income support and rural development policies. This seems a very appropriate time to do so, given that a not negligible cut to CAP spending and its further reform are now discussed in the EU (European Commission, 2018). Such actions may require a reorientation of the scarce resources between measures aimed at providing income support and measures aimed at other policy relevant objectives.

Section 2 presents the conceptual framework and the estimation strategy used in carrying out the analysis. Section 3 shows the data, how we define the farm households and the relevant covariates used to account for observable characteristics of households affecting income level. Section 4 comments the most important results and finally the article concludes in section 5, providing some policy recommendations.

## 2. METHODOLOGY

The ideal setting to estimate the income differential between farm and non-farm households would be an experiment that randomizes them dividing them into a first "treated" group

whose main income source comes from the farm sector, and a second "control" group whose income comes from a different production activity. Phrasing it differently, working in agriculture should be viewed as a specific treatment applied to a group of households, which, in turn, influences their incomes with respect to the other group.

Such experiment is clearly not feasible. The analysis has to rely only on observational data and need to address a missing-data problem, since we cannot observe what a group of households would have earned if it had belonged to the other group. A strategy to mimic the experiment is creating a control group among households that has similar characteristics to the treated group. Creating a "counterfactual" according to the potential outcome framework (Rubin, 1974; Heckman and Navarro-Lozano, 2004; Imbens, 2004; Wooldridge, 2010) provides a practical solution to the problem, even though the absence of an exogenous source of variation in the observed data does not allow genuine statistical inference on causal relations between the "treatment" (in our case being a farmer) and the outcome (income level). The goal of our analysis is more simply to compare the economic welfare of farming households with other families as much as possible similar in all observable factors driving the income level, except for the sector of activity (agriculture vs. other sectors). Such approach can also be found in the empirical literature estimating inter-sector differences (e.g. Lucifora and Meurs, 2006; Glinskaya and Lokshin, 2007; Gimpelson and Lukiyanova, 2009).

We use two strategies to estimate potential outcomes: regression adjustment (RA) and covariate matching (CM) methods. RA approach is based on OLS regression and assumes that one among the two sectors or groups under scrutiny is a treatment. Accordingly, the estimator uses a two-step approach: i) two separate regression models of the outcome (the household income) on a set of covariates for each group are estimated; ii) averages of the predicted outcomes for each subject and treatment level are then computed and their difference represents the treatment effects. Since income is a continuous variable, RA simply fits two

OLS regressions of income on the covariates, one for each group, and then uses means of predicted outcomes for both farm and non-farm households for computing the estimated income difference.[5]

Despite its intuitiveness, the RA approach shows some disadvantages. First, it cannot be easily detected if "treated" and "non-treated" belong to the same region of the n-dimension space of covariates.[6] Moreover, if the difference between the average values of the covariates in the two groups is large, the results are sensitive to the linearity assumption of regressions. Finally, the choice of covariates to be included in the model strongly affects the results (model dependence problem).

To give strength to the RA estimates, we follow a second estimation approach employing non-parametric covariate matching (CM) methods, which implement nearest-neighbor matching estimators. The main advantage of CM is that they do not require specifying the functional form of the income equation and are therefore not susceptible to bias due to misspecification of the model (King and Nielsen, 2016). What a matching estimator simply does is, for each farm household, imputing the missing outcome by using the average outcome of "similar" non-farm households. Similarity between subjects is based on a weighted function of the covariates for each observation. The idea is to match farm households with a "control" group of non-farm households that are similar in all relevant characteristics. In such a way, observed income differences between the two groups can be attributed to the sector effect.

[5] Using the terminology of quasi-experimental inference such a difference could be defined an Average Treatment Effects of the Treated (ATET). The regression adjustment is estimated through the Stata routine *teffetcsra*.

[6] In other words if for each possible covariate in the population, the probability of any "non-treated" observation to be a "treated" one is included between 0 and 1 (overlap assumption).

We implement the matching method proposed by Abadie et al. (2004) and Abadie and Imbens (2011) because it also considers the bias deriving from multidimensional covariates and adjusts for it. Their procedure allows individual observations to be used as a match more than once (matching with replacement). In particular, we employ the Mahalanobis distance, where the weights are based on the inverse of the covariates' variance-covariance matrix. A treated observation is matched with one control observation. For robustness, we repeated the analysis also matching one treated with 4 control observations. Also, the inverse variance metric was used as a robustness check. The four alternative matchings yielded very similar results. In the following sections, the outcomes of the Mahalanobis (1:1) estimator are provided because it shows the best balance in the covariates for the matched observations, an indicator of the quality of obtained matching.[7]

Finally, the two methods considered above account for complex survey design by estimating these through the inclusion of weights. Note that the failure to do so generally results in serious underestimation of standard errors (Kish 1995; Lohr 2000). Moreover, Kott (1991) shows that weighted estimates are more robust to omitted variable problems and to heteroscedasticity that normally characterizes sample survey data. Since using sample weights does not overcome the problem of outliers, we also recalibrate weights adopting the Van

[7]A perfectly balanced covariate has a standardized difference of zero and a variance ratio of one. There are no standard errors on these statistics, so inference is informal (Austin, 2009, Rosenbaum and Rubin, 1985). Since in our case the weighted standardized differences are all close to zero and the variance ratios are all close to one, we are confident that covariates are quite well balanced in our model. The covariate matching is estimated through the Stata routine *nnamtch.*

Kerm's rule of thumb (Alfons et al., 2013) and using the approach proposed by Alfons and Templ (2013).[8]

## 3. DATA

The European Union Statistics on Income and Living Conditions (EUSILC) is a harmonized survey that collects multidimensional microdata in Europe (Eurostat, 2007). In particular, we consider the time series 2008-2016 and the countries belonging to the European Union clustered in three macro areas: Western Continental (Austria, Belgium, Germany, Denmark, Finland, France, Ireland, Luxembourg, Netherland, Sweden and United Kingdom); Central Eastern(Bulgaria, Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Romania, Slovenia and Slovakia); and Mediterranean (Cyprus, Malta, Greece, Spain, Italy and Portugal).

The availability of a detailed set of data on level and composition of income for a representative sample of European households allows overcoming several methodological difficulties. First, alternative definitions of the agricultural household can be adopted based on the composition of household incomes (Hill, 2012; OECD, 2002; United Nations, 2012). Farm households can be identified according to two definitions. The first is a "broad" definition referring to those families that have at least one self-employed member working in agriculture. The second is the "narrow" definition of the "agricultural households sector" (United Nations, 2012): it considers as farm households only those with a farm income representing the main source of income (i.e. at least half of the total household income). The analysis will focus on the average income of narrow farm households, compared with the average income of narrow non-farm households, i.e. households where non-farm self-employed labour is at least 50% of total households' income. Details on the identification of farm and non-farm households within the EUSILC dataset can be found in the Appendix.

[8]To implement the recalibration of weights we used the R package *laeken*.

The first income variable considered in the analysis is the level of equivalised disposable income that refers to the total disposable household income divided by the equivalised household size.[9] According to the EUSILC guidelines, the variable includes only monetary sources of income (earning from labor, pensions and other transfers, income from capital assets). However, household well-being might also come from non-monetary sources of income, namely the implicit rents from dwelling on farm and in-kind incomes from self-consumption of produced goods. Since the EUSILC dataset also provides information on these additional sources of income, we consider in the analysis an extended definition of income that includes also these non-monetary sources.

To ensure a full comparability across different countries and along the whole period, all income data have been transformed to account for differences in price levels (adjusting for purchasing power parities, PPP) and price changes over time through the Harmonized Indices of Consumer Prices (all values expressed in Euro 2015).[10]

The EUSILC database provides variables that can be used to account for observable differences among households and are recognized as important determinants of household income in the literature (Becerril and Abdulai, 2010; De Janvry and Sadoulet, 2001; Kassie et al., 2011; Mendola, 2007; Yúnez-Naude and Taylor, 2001): age, education, marital status, health condition and sex of the householder, the number of family members and the urban/rural residence of the household.[11] Statistically significant differences exists for almost

[9]The equivalence scale used in the EUSILC survey is equal to 1 for the reference person, 0.5 for other adult members (14 years old or elder) and 0.3 for members up to 13 years old.

[10]Eurostat provides the coefficients to perform Purchase Power Parities and price variation adjustments. Details on the methodology can be found in (Mack and Lange, 2015).

[11] Other unmeasurable and/or unmeasured factors could affect the income and/or the decision of being farmer. Before proceeding with estimates we exploited the information included in

all these characteristics between farm and non-farm households. Table 1 shows the average values of covariates in the groups of narrow farm and non-farm self-employed households in 2015. At the EU level, the differences are significant for all variables except for the health status indicator. The reference person of a farming family is on average older, more frequently male, married and with a lower education attainment. Farm households are on average larger and more than 70% of them live in rural areas (compared to only 24% of non-farm ones).

PLACE TABLE 1 HERE

## 4. RESULTS

The raw (i.e. unadjusted) average income levels of our comparison groups can provide a preliminary description of farm households income conditions compared to non-farm households. Figure 1 compares the income of farm households (according both to the broad

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the EUSILC database to test if the presence of endogeneity would be likely to bias our results. Using data available in the EUSILC wave 2011 only we created a dummy variable if at least one of the two parents was a farmer. The use of the parental sector of employment as an instrumental variable in testing the presence of endogeneity is possible practical solution even though still subject to discussion (Trostel et al., 2002; Pons and Gonzalo 2003; Hoogerheide et al., 2012; Danzer 2013; Gong, 2019). We checked for the presence of endogeneity estimating a bivariate recursive mixed model that employs a multi-equation setting (Roodman, 2010). Results suggests that there is no endogeneity in our data. Although this cannot be considered as a conclusive evidence of the absence of relevant unobservables, the rejection of the endogeneity test gives us a greater confidence that the results of the RA model and the CM estimates are likely to not be biased. Further details on data a methods used can be found in the Appendix.

and the narrow definition) with the total population from 2008 to 2016.[12] A quick look at the graphs clearly suggests that a farm household's income problem still exists in the EU. The average income of agricultural households lies well below the average income of the whole EU population along the whole period. Remarkable differences can be observed, however, among the three geographical groups of EU countries.

PLACE FIGURE 1 HERE

With reference to the average income of the total population, the income of the Western Continental countries is higher than the whole EU population while the opposite is true for the Central Eastern countries, where it is only 1/2 of the EU average even if expressed in PPP. Finally, Mediterranean countries have a very similar level of income in comparison with the average EU level.

Regarding the relative position of farm households within the whole population, Western Continental countries differ from the other two groups in two different ways. First, differently from the rest of the EU, in these countries the income level of farm households in a broad sense is comparable with that of the total population level along the whole period. Second, in the group of Western Continental, the income of narrow farm households (i.e. only the group of households for which farming is the main source of income) is even higher than the average of all households. Hence, households managing agriculture as a secondary source of income (i.e. all not-narrow farmers), show on average an income level that is lower than the income of narrow farmers. This polarization within the agricultural household sector does not appear in Central Eastern and Mediterranean countries, where the average income of farm

[12]Total population includes also farm households. Year 2016 is not completely comparable with the previous ones, as five countries are not present in the dataset (Ireland, Luxembourg, Cyprus, Malta, Italy).

households according to the two alternative definitions essentially overlaps along the whole period.

We now focus on narrow farm households and narrow non-farm self-employed households only because we aim at comparing the most similar groups except for the sector in which they mainly derive their income. Before estimating the income differential, we show the gap between these two groups over time by using the raw income ratio (Figure 2).

PLACE FIGURE 2 HERE

The income differential between narrow farm and non-farm households is generally twice the one observed when the narrow farm households are compared with the whole population. This is because the income of non-farm self-employed households is way larger than the overall population. At the EU level, narrow farm households' income varies between 40% and 55% with respect to non-farm self-employed households over the whole period. However, the relative level of narrow farm households' income differs across the three groups of EU countries: on average, it is around 40% of non-farm households in Central Eastern, 60% in Mediterranean and between 60 and 80% in Western Continental EU countries. Finally, note that the relative farm income level fluctuates over time. This is probably due to the fact that farm income level is affected by weather conditions that affect production levels, as well as changes in agricultural product prices over time (Mishra and El-Osta, 2001; Mishra and Sandretto, 2002: Moschini and Hennessy, 2001). For example, it is relatively high in 2012 in almost all groups of countries. Furthermore, it often varies considerably over time as it is the case of Western Continental between 2010 and 2012 or between 2015 and 2016 in all groups of countries but the Mediterranean countries.

The above results introduce some considerations that will drive the rest of the article. To start with, an income gap seems to exist. Second, the extent of the income gap differs among EU geographical areas: this is true in terms of absolute as well as in relative levels. Hence, it

seems important to account for the country of households when comparing farm and non-farm households. Third, because of the observed variability of income levels over time, the income differential is estimated for each year to assess whether this differential is persistent over time or not.

4.1 *Controlling for differences in households' and countries' characteristics*

So far, we showed only raw income differences. However, to better estimate if an income difference exists between the two narrow groups, we need to control for differences in observable characteristics, which might explain the gap.

As explained in Section 2, we employ a specific empirical strategy, which adjusts for the differences in income deriving from such observable characteristics and isolates differences coming from a "pure" industry effect. We thus start by using Regression Adjustment (RA) techniques, namely a set of regressions that control from heterogeneity coming from covariates and from country belonging and then move to covariate matching estimates. The figures in table 2, referring to year 2015,[13] show that adjusting for differences in observable characteristics markedly reduces the income differential between the two groups.

PLACE TABLE 2 HERE

After adjusting for the different characteristics of households, the estimated income gap is still statistically significant but more than halved, moving from 11,224.11 to 5,621.34 Euros (-50%) in comparison to the model without covariates. The income gap further decreases by controlling countries differences. The RA estimates give an income differential of 3,312.11 Euros, 70% lower than the unadjusted estimate based on raw means. This result is expected, given the differences in observable characteristics (see table 1) and the large differences in

[13]The estimates for the whole 2008 – 2016 series are provided in table A.2 in the Appendix.

economic and structural conditions that still exist across the EU member states and that can affect household incomes.

The last row of table 2 shows the results from the covariate matching. According to CM estimates, the average income gap decrease to 3,249.11 Euros (-71%).

4.2 *Going beyond EU averages*

The 2015 estimates clearly suggest that, at the aggregate EU level, an income differential still exists between narrow farm and non-farm self-employed households, even after controlling for household and country characteristics. However, the extent of this differential varies across the EU members according to specific geographical areas. Table 3 disaggregates the results for year 2015 by groups of countries and compare alternative estimates according to RA and CM approach respectively.

PLACE TABLE 3 HERE

A quick glance to the above table highlights interesting results. First, raw means reveal the presence of relevant differences within the three considered areas, as we already know from Figure 2. Second, observed characteristics of households and countries heterogeneity explain most of the difference among farm and nonfarm households. Finally, when considering the CM a further reduction of the income gap between farm and non-farm households is observed in Central Eastern and Western Continental countries in comparison with that obtained by RA. Furthermore, income differentials estimated by CM show a low level of statistical significance in Western Continental countries. This shows that in 2015 the residual "pure" industry effect (after accounting for individual and country characteristics) tends to vanish at least in part of EU member states.

Table 4 shows the results disaggregated for each year. The changes of the income disparity over time comes with no surprise, given the stochastic nature of the farm income as previously discussed. Despite the inter-annual variability, the estimates based on raw mean

values show that income disparities exist along the whole period both at the EU level and within the three groups of countries. However, similarly to our previous results, the income gaps become smaller and often vanish when the estimates are adjusted using OLS regression and covariate matching. Overall, RA and CM yield similar results. The income differential at the EU level is always with the negative sign, but became smaller and it is not significative in some years depending on the estimation method: 2012 and 2013 according to RA estimates, 2008 when CM results are considered.

PLACE TABLE 4 HERE

Central Eastern show a persistence of a significative income gap over time according to both RA and CM estimates. Conversely, the significance of differentials estimated for the other two groups of countries tends to vanish in several years, depending again on the estimation method: while in Mediterranean countries, according to RA estimates there is only feeble or no evidence of an income gap in 5 over 9 years (2009, 2012, 2013, 2014 and 2016), according to CM results Western Continental countries show a significant income gap in only 3 over 9 years (2010, 2014 and 2016). In other words, when considering a "counterfactual" logic, the "pure" sector differential seems to disappear.

A further insight on the farm income problem can be achieved by looking to the extended definition of income . When the income gaps are estimated by taking into account also non-monetary sources of income, they are systematically lower in absolute terms than those referring to monetary incomes only. The graph in Figure 3, shows that at the EU level the inclusion of in-kind income from self-consumption and imputed rents actually *improve* the relative position of narrow farm households compared with the group of narrow, non-farm self-employed households, increasing the average farm to non-farm income ratio along the whole period. The same could be observed looking at results disaggregated by group of countries.

PLACE FIGURE 3 HERE

According to the estimates in table 5, when considering non-monetary sources of income, relevant differences still emerge comparing groups of countries.

PLACE TABLE 5 HERE

While at the European level the income gap is almost always significant (with the exception of a feeble significance in 2012 according to both RA and CM estimates), in Mediterranean countries the evidence of the income gap according to RA estimates is further reduced, with a negative and significative differential in only in 2 years (2010 and 2011); Western Continental countries show none or only feeble evidence of a negative income gap in 5 over 9 years when CM estimates are considered. Differently, in Central Eastern countries, the inclusion of non-monetary sources of income does not alter the fact that a significant and persistent income gap exists between farm and non-farm households, whatever the estimation method. A view to data disaggregated by source (self-consumption of own produced goods or imputed rents, available in table A.3 and A.4 in the Appendix) shows that farm households are more advantaged by the inclusion of imputed rents in the measurement of income. The relative importance of imputed rents from dwelling within the total income could be considered also as an indicator of household's *wealth*.[14] Hence, such a result suggest that factor endowments, such as the distribution of real estate assets ownership, may contribute to explain the relatively better-off position of narrow farm households compared with the rest of the population.

## 5. CONCLUSIONS

[14] This seems in-line with the findings that in the USA farm households have greater wealth than non-farm households as a whole and that broadened their portfolio to include more nonfarm investments (Mishra et al., 2002).

This study provides an empirical test for the existence of an income differential between farm and non-farm households in the European Union considering also the income farmers receive from non-farm sources. The use of a harmonized pan-European survey (EUSILC) allowed a systematic comparison of income levels of narrow farm and narrow non-farm self-employed households across the whole EU and within three groups of EU Member States for 9 years (2008 – 2016). Furthermore, the definition of income has been extended including in-kind incomes from self-consumptions and imputed rents from properties. To our knowledge, this is the first time that such a comprehensive analysis is carried out for the EU.

Following a "counterfactual" logic, two empirical approaches have been used to take fully into account the observable households characteristics that could influence income differentials.

Three main results of the analysis should be stressed. First, the relative position of farm households strongly differs across European countries. While at the EU level the income of narrow farm households is sensibly lower than other self-employed households, Western Continental countries displays a smaller gap. Farm households are relatively more disadvantaged in Central Eastern countries, where the income gap seems to be relatively persistent over time. Conversely, in Mediterranean and, even more, in Western Continental EU members, the income differential between farm and non-farm households appears to be unstable over time and often not statistically significant. Second, while the simple comparison of raw income means reveals a systematic and non-negligible income gap between narrow farm and non-farm households, the extent of such gap strongly declines when controlling for differences between farm and non-farm families (i.e. age, marital status, education, health, family size, rural residence) and for countries differences. This means that these characteristics are responsible for most of the income gap and that the simple comparison of raw income figures is misleading. Third, adding to previous literature, we found that when

non-monetary sources of income are included in the income measure, the relative position of farm households seems to improve across all groups of countries.

Taken together, these results shed light on the nature of the farm households' income problem in the European Union and suggest some policy implications. A first dimension of the problem concerns the inclusion of farm households among the socially disadvantaged groups of European peoples. The comparison of farm households' incomes with those of the total population shows that, at least in some EU countries (e.g., Central Eastern countries), a policy justification for supporting the *absolute* level of the total income of farming families still exists. Indeed, the average income of farm households is still lower than the average of the European households. However, this is no longer true in all EU members and particularly in the case of Mediterranean and Western Continental countries. The upcoming CAP reform should carefully address the targeting of income support. Our findings suggest that room exists for a redistribution of direct income support both across Member States (in favor of Central Eastern countries) and within the agricultural households sector, from narrow farmers, showing an income *above* the average of the total population, towards households managing agriculture as a secondary source of income, that are poorer than their narrow counterpart. In any case, a renewed debate should be promoted about the trade-offs generated by the inclusion of *general* social objectives (such as the income support of a socially disadvantaged group) among the goals of a *sector* policy like the CAP. The redistribution of CAP payments towards poorer, not-narrow farm households, though justified by overall equity purposes, would be likely to conflict with the attempt to direct the support only to "active" or "genuine" farmers carried out by the EU during the last two decades (Pupo d'Andrea and Romeo Lironcurti, 2017). Our results suggest that narrow farmers, at least in the Western Continental countries, are on average better-off when compared to the total population, but according to the current CAP they are also likely to be classified as active farmers, that is people managing

a real production activity, and entitled to receive decoupled CAP payments designed to support incomes.

A second dimension concerns the existence of an industry-specific disadvantage faced by farmers. According to our results, "living of agriculture" as a self-employed household in Europe still means earning incomes that are lower than self-employed households working in other sectors. However, a relevant part of these differentials can be explained by households' characteristics, such as age, education attainment and rural residence. Such differences can be addressed by specific rural development policies, such as those supporting the entry of young farmers or professional training, and promoting social inclusion and economic development in rural areas. The residual income differential (i.e. after controlling for the household characteristics) is likely to depend more on differences in terms of efficiency in the use of production factors between agriculture and other production activities. Again, our results show that this "pure" industry effect on farm - nonfarm income gap cannot be longer considered as a common problem across all EU states. In Western Continental and Mediterranean countries, when non-monetary sources of income (mainly imputed rents for dwellings on the owned farm) are also considered, this residual part of the income gap appears to be even more the expression of the intrinsic variability of farm income (due to factors the farmers cannot control, such as weather or market conditions) than the consequence of a structural disadvantage of agriculture. Specific policy measures to implement a sector-specific and more efficient insurance system in agriculture could be designed because it still represents a minor component of the European CAP (Bardaji and Garrido, 2016).

The analysis presents some limits. While the dataset we employed is representative of the whole households' sector in Europe, it may fail to properly represent farm households. In designing our empirical strategy, we addressed this problem in three ways: using sample

weights and robust estimation techniques, reducing the impact of possible influential observations on results; analyzing income differentials at the level of large (even though differentiated) groups of countries; adopting non-parametric covariate matching methods to estimate the income differential.

The focus of our analysis is on average income level and not on the distribution of the income. Consequently, the current research neither assesses whether poverty issues are relatively more frequent within the farm households nor income distributional issues that have been explored in previous analyses (e.g. de Frahen et al., 2018; Katchova, 2008). These are clearly policy-important issues. The research presented in this article, however, provides a first important building block of a more comprehensive analysis of the income conditions of farm households in the EU. We plan to address this relevant issue in a future analyses.

A further limitation concerns the lack of data regarding, specifically, the farm activities, including the amount of support provided by the CAP. This is a relevant limitation from a policy analysis perspective especially because it does not allow a proper investigation of the role of agricultural policy measures in enhancing the economic well-being of agricultural households. We agree with Hill and Bradley (2015) stressing the need to extend the current sector-oriented statistics on agriculture in Europe beyond the farm borders, to provide a harmonized and reliable information on the total income of agricultural households. Conversely, household based surveys such as EU-SILC may include farm specific information useful for policy analysis including the amount of support coming from agricultural policies and other characteristics of the farm.

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**Table 1**
**Differences in observable characteristics of self-employed households**
**All EU countries. Year 2015 (Standard errors in parentheses)**

| | Farm (narrow) | Non-farm | Difference | |
|---|---|---|---|---|
| Age | 48.47 | 46.68 | 1.79 | *** |
| | | | (0.38) | |
| Male | 0.87 | 0.74 | 0.13 | *** |
| | | | (0.01) | |
| Married | 0.55 | 0.40 | 0.15 | *** |
| | | | (0.02) | |
| Education level | 2.67 | 3.53 | -0.86 | *** |
| | | | (0.04) | |
| Health status | 0.59 | 0.60 | -0.01 | |
| | | | (0.02) | |
| Household size | 2.19 | 1.86 | 0.33 | *** |
| | | | (0.04) | |
| Rural residence | 0.76 | 0.22 | 0.54 | *** |
| | | | (0.02) | |

Source: own elaboration on EUSILC data
* p< 0.10, ** p < 0.05, *** p < 0.01

**Table 2**
**Average income differentials between narrow farm and other self-employed households in the EU**
**Whole EU. Year 2015. Euro 2015PPP (Standard errors in parentheses)**

| | Estimated income differential | |
|---|---|---|
| Regression, no covariates | -11,224.11 | *** |
| | (778.65) | |
| Regression with covariates | -5,621.34 | *** |
| | (758.09) | |
| Regression with covariates and country dummies | -3,312.11 | *** |
| | (867.70) | |
| Covariate Matching | -3,249.11 | *** |
| | (802.01) | |

* p< 0.10, ** p < 0.05, *** p < 0.01
Source: own elaboration of on EUSILC data.

**Table 3**
**Income differentials between farm and non-farm self-employed households in 2011 Whole EU and country groups. Year 2015. Euro 2015PPP (Standard errors in parentheses)**

| | Non-Farm Households | Farm Households | Estimated income differential | | |
|---|---|---|---|---|---|
| | | | Raw mean values | | |
| Whole EU | 23,025.15 | 11,801.04 | -11,224.11 | (778.65) | *** |
| Central Eastern | 12,857.72 | 5,969.33 | -6,888.40 | (381.89) | *** |
| Mediterranean | 18,363.11 | 10,609.11 | -7,754.00 | (640.45) | *** |
| Western Continental | 31,109.00 | 23,034.80 | -8,074.20 | (1,894.87) | *** |
| | | | Regression Adjusted with covariates | | |
| Whole EU | 17,422.38 | 11,801.04 | -5,621.34 | (758.09) | *** |
| Central Eastern | 10,157.26 | 5,969.33 | -4,187.93 | (403.93) | *** |
| Mediterranean | 14,650.68 | 10,609.11 | -4,041.57 | (747.69) | *** |
| Western Continental | 27,639.24 | 23,034.81 | -4,604.43 | (2,040.14) | ** |
| | | | Regression Adjusted with covariates and country dummies | | |
| Whole EU | 15,113.15 | 11,801.04 | -3,312.11 | (867.70) | *** |
| Central Eastern | 7,715.14 | 5,969.33 | -1,745.81 | (375.10) | *** |
| Mediterranean | 12,210.03 | 10,609.11 | -1,600.92 | (736.74) | ** |
| Western Continental | 30,336.18 | 23,034.81 | -7,301.37 | (2,704.82) | *** |
| | | | CovariateMatching | | |
| Whole EU | 15,050.15 | 11,801.04 | -3,249.11 | (802.01) | *** |
| Central Eastern | 7,483.12 | 5,969.33 | -1,513.79 | (257.71) | *** |
| Mediterranean | 13,331.47 | 10,609.11 | -2,722.36 | (533.23) | *** |
| Western Continental | 27,968.87 | 23,034.81 | -4,934.06 | (2,569.94) | * |

* p< 0.10, ** p < 0.05, *** p < 0.01
Source: own elaboration of on EUSILC data

**Table 4**
**Income differential between farm and non-farm self-employed households.**
**Raw mean values, regression adjusted and covariate matching estimates.**
**Whole EU and country groups. Years 2008 - 2016. Euro2015 PPP (Standard errors in parentheses)**

| | Estimated income differential | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2008 | | 2009 | | 2010 | | 2011 | | 2012 | | 2013 | | 2014 | | 2015 | | 2016 | |
| **Equivalised disposable income: raw mean values** | | | | | | | | | | | | | | | | | | |
| Whole EU | -14,876.98 | *** | -15,109.31 | *** | -14,410.63 | *** | -13,616.88 | *** | -10,378.69 | *** | -11,893.53 | *** | -11,737.63 | *** | -11,224.11 | *** | -14,924.78 | *** |
| | (1,068.15) | | (696.68) | | (670.37) | | (662.37) | | (629.64) | | (845.95) | | (772.06) | | (778.65) | | (1,089.71) | |
| Central Eastern | -5,357.42 | *** | -7,391.00 | *** | -6,416.55 | *** | -7,167.20 | *** | -6,858.56 | *** | -7,038.13 | *** | -7,233.84 | *** | -6,888.40 | *** | -7,375.46 | *** |
| | (385.41) | | (498.96) | | (327.28) | | (380.88) | | (322.22) | | (354.43) | | (304.18) | | (381.89) | | (346.99) | |
| Mediterranean | -9,354.80 | *** | -9,457.66 | *** | -9,316.67 | *** | -10,165.56 | *** | -7,559.00 | *** | -7,665.61 | *** | -7,123.07 | *** | -7,754.00 | *** | -4,342.02 | *** |
| | (699.45) | | (802.14) | | (714.73) | | (733.11) | | (897.70) | | (719.77) | | (767.33) | | (640.45) | | (1,591.42) | |
| Western Continental | -16,510.44 | *** | -13,741.11 | *** | -13,182.55 | *** | -10,875.58 | *** | -6,118.18 | *** | -6,879.76 | *** | -8,724.22 | *** | -8,074.20 | *** | -12,034.48 | *** |
| | (3,248.12) | | (2 073.25) | | (1 868.91) | | (1 594.86) | | (1 418.75) | | (2 563.24) | | (1 945.08) | | (1 894.87) | | (1,940.93) | |
| **Equivalized disposable income: regression adjusted** | | | | | | | | | | | | | | | | | | |
| Whole EU | -2,162.30 | ** | -2,083.55 | *** | -2,694.87 | *** | -2,828.48 | *** | -1,152.62 | * | -1,421.72 | | -2,050.18 | ** | -3,312.11 | *** | -4,047.06 | *** |
| | (975.39) | | (685.92) | | (712.28) | | (634.06) | | (621.97) | | (906.87) | | (842.46) | | (867.70) | | (1,056.44) | |
| Central Eastern | -645.45 | * | -1,484.37 | *** | -1,248.00 | *** | -1,288.50 | *** | -1,193.96 | *** | -2,056.26 | *** | -1,590.10 | *** | -1,745.81 | *** | -2,403.66 | *** |
| | (342.50) | | (389.22) | | (337.84) | | (339.77) | | (339.59) | | (416.62) | | (316.33) | | (375.10) | | (376.98) | |
| Mediterranean | -1,801.59 | ** | -1,323.61 | | -2,457.79 | *** | -2,632.79 | *** | 411.04 | | -681.29 | | -717.03 | | -1,600.92 | ** | 970.59 | |
| | (724.66) | | (903.05) | | (802.59) | | (886.58) | | (1,002.88) | | (733.09) | | (804.68) | | (736.74) | | (1,597.29) | |
| Western Continental | -5,705.73 | * | -5,276.08 | ** | -8,657.24 | *** | -6,362.01 | *** | -3,700.08 | ** | -4,035.52 | | -7,270.28 | *** | -7,301.37 | *** | -11,163.67 | *** |
| | (3,189.59) | | (2,304.07) | | (2,448.86) | | (1,820.82) | | (1,601.64) | | (3,366.79) | | (2,743.20) | | (2,704.82) | | (2,682.68) | |
| **Equivalized disposable income: covariate matching** | | | | | | | | | | | | | | | | | | |
| Whole EU | -2,948.90 | | -2,097.92 | *** | -3,485.13 | *** | -2,713.81 | *** | -1,087.47 | ** | -1,323.52 | ** | -2,569.57 | *** | -3,249.11 | *** | -3,408.86 | *** |
| | (2,277.34) | | (470.55) | | (553.28) | | (986.04) | | (434.32) | | (533.97) | | (462.33) | | (802.01) | | (710.20) | |
| Central Eastern | -977.01 | *** | -1,870.83 | *** | -1,677.43 | *** | -1,612.67 | *** | -1,163.80 | *** | -1,277.61 | *** | -1,637.74 | *** | -1,513.79 | *** | -2,013.72 | *** |
| | (255.01) | | (220.01) | | (220.30) | | (215.93) | | (179.78) | | (246.23) | | (253.78) | | (257.71) | | (282.85) | |
| Mediterranean | -1,212.38 | ** | -1,764.98 | *** | -2,334.92 | *** | -1,956.89 | *** | 280.24 | | -1,622.45 | *** | -1,849.84 | *** | -2,722.36 | *** | 361.82 | |
| | (566.80) | | (673.75) | | (550.80) | | (592.93) | | (848.84) | | (588.44) | | (691.39) | | (533.23) | | (607.48) | |
| Western Continental | -7,777.12 | | -3,061.29 | * | -9,218.02 | *** | -4,992.97 | | -2,032.91 | | -1,106.46 | | -5,080.81 | *** | -4,934.06 | * | -10,982.07 | *** |
| | (8,144.64) | | (1,818.60) | | (2,431.24) | | (3,449.63) | | (1,265.11) | | (2,217.19) | | (1,615.54) | | (2,569.94) | | (2,949.05) | |

* p< 0.10, ** p < 0.05, *** p < 0.01
Source: own elaboration of on EUSILC data

**Table 5**
**Extended income[a] differential between farm and non-farm self-employed households.**
**Regression adjusted and covariate matching estimates**
**Whole EU and country groups. Years 2008 - 2016. Euro2015 PPP (Standard errors in parentheses)**

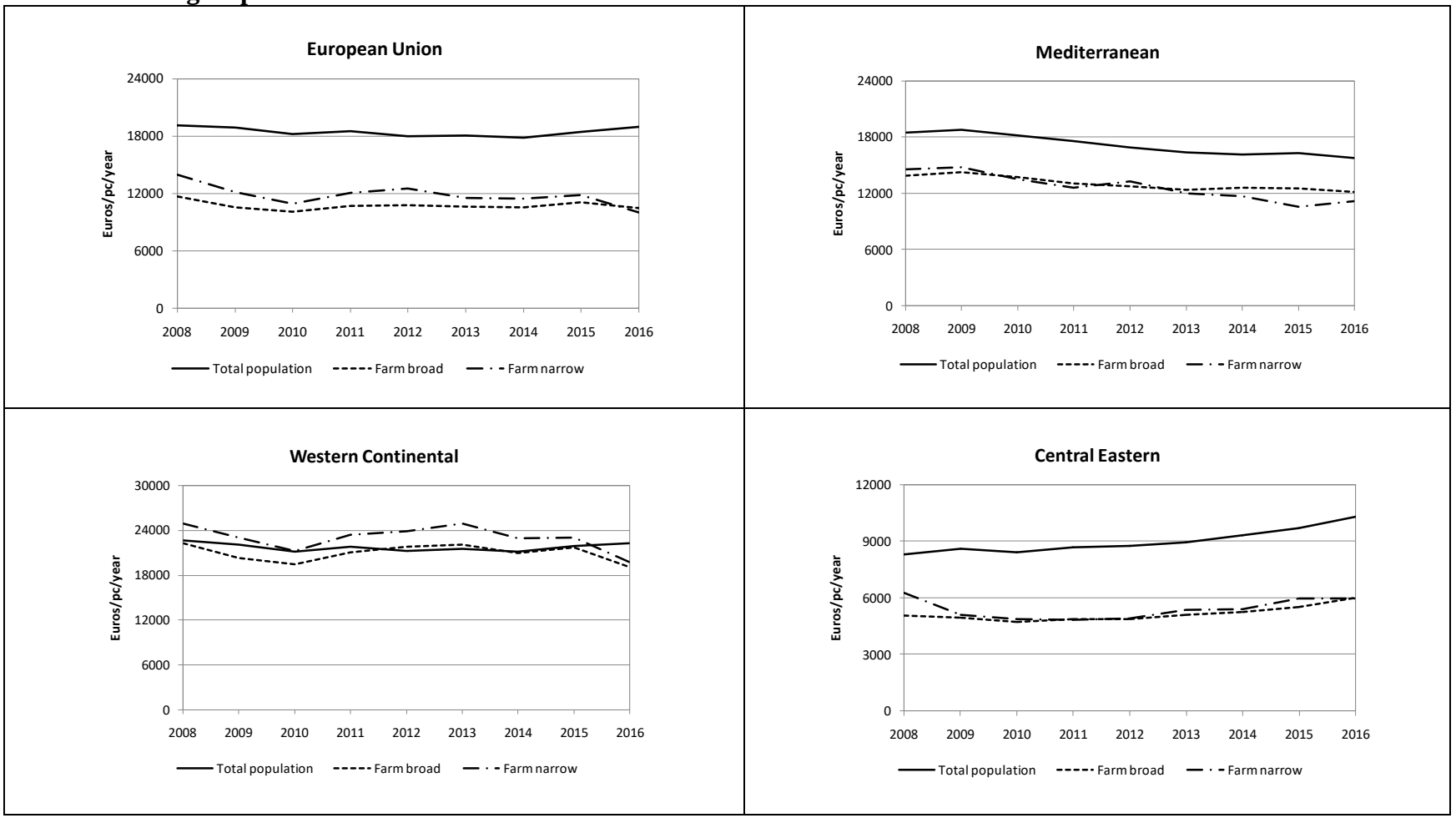
| | Estimated income differential | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| | | | | Regression adjusted | | | | | |
| Whole EU | -2,025.20 ** | -2,037.59 *** | -2,549.33 *** | -2,495.61 *** | -851.09 | -1,242.27 | -1,939.48 ** | -3,282.56 *** | -4,087.26 *** |
| | (980.76) | (707.49) | (736.47) | (649.31) | (637.51) | (920.49) | (860.96) | (889.24) | (1,120.20) |
| Central Eastern | -,583.94 | -1,222.86 *** | -1,020.45 *** | -1,022.09 *** | -,901.06 ** | -1,903.75 *** | -1,442.28 *** | -1,658.82 *** | -2,220.37 *** |
| | (360.61) | (406.57) | (,358.17) | (353.51) | (350.52) | (435.80) | (338.47) | (381.86) | (380.24) |
| Mediterranean | -1,429.13 * | -961.57 | -2,030.22 ** | -2,291.17 ** | 419.18 | -268.14 | -394.32 | -1,298.53 * | 987.83 |
| | (743.34) | (921.69) | (826.77) | (916.75) | (1 044.08) | (752.66) | (821.05) | (777.36) | (1,635.65) |
| Western Continental | -5,792.11 * | -5,885.45 ** | -8,825.24 *** | -5,849.31 *** | -3,059.65 * | -3,854.96 | -7,395.09 *** | -7,441.88 *** | -11,459.28 *** |
| | (3,197.15) | (2,343.10) | (2,529.48) | (1,866.59) | (1,638.52) | (3,381.56) | (2,789.51) | (2,739.67) | (2,815.88) |
| | | | | Covariate matching | | | | | |
| Whole EU | -2,895.59 ** | -2,098.91 *** | -3,392.53 *** | -2,446.40 ** | -809.24 * | -1,065.44 ** | -2,549.41 *** | -3,241.33 *** | -3,319.43 *** |
| | (1,309.37) | (470.67) | (568.28) | (1,001.53) | (447.86) | (542.82) | (487.87) | (822.90) | (733.03) |
| Central Eastern | -965.65 *** | -1,714.01 *** | -1,605.50 *** | -1,428.48 *** | -971.88 *** | -1,217.35 *** | -1,640.29 *** | -1,420.82 *** | -1,777.06 *** |
| | (284.36) | (252.70) | (244.89) | (237.15) | (186.81) | (266.11) | (317.03) | (272.50) | (287.84) |
| Mediterranean | -1,069.54 * | -1,615.17 ** | -2,014.71 *** | -1,569.56 ** | 186.66 | -1,406.98 ** | -1,813.19 ** | -2,693.04 *** | 194.57 |
| | (587.34) | (702.39) | (567.57) | (622.70) | (862.48) | (606.18) | (713.87) | (554.90) | (615.14) |
| Western Continental | -7,660.94 * | -3,525.63 ** | -9,339.99 *** | -4,657.77 | -1,285.55 | -351.29 | -5,024.24 *** | -5,097.24 * | -11,196.64 *** |
| | (4,630.37) | (1,775.88) | (2,474.85) | (3,498.50) | (1,308.53) | (2,240.18) | (1,676.44) | (2,638.23) | (3,051.24) |

* p< 0.10, ** p < 0.05, *** p < 0.01

[a] Equivalized disposable income plus in kind incomes from self-production plus imputed rents

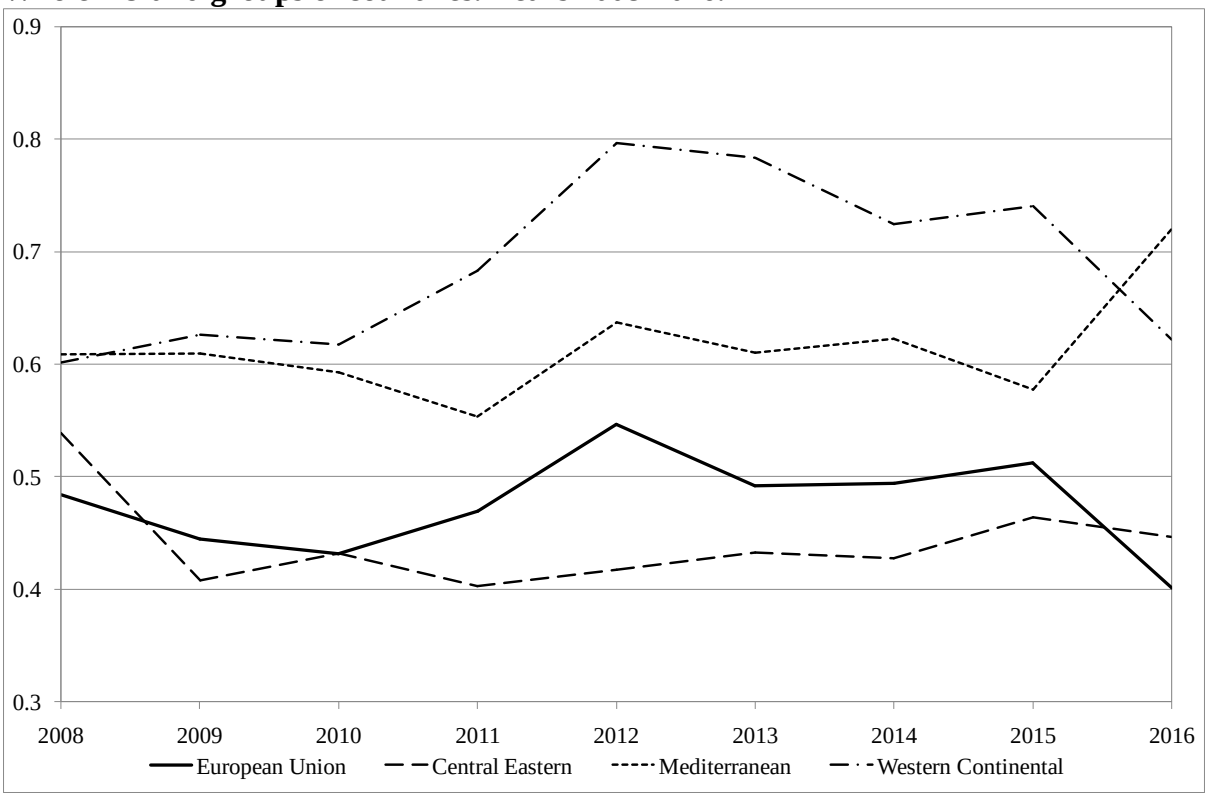
Source: own elaboration of on EUSILC data

**Figure 1**
**Evolution of farm and total population household income levels.**
**Per capita equivalised disposable income (Euro 2015 PPP).**
**Whole EU and groups of EU countries. Years 2008-2016.**



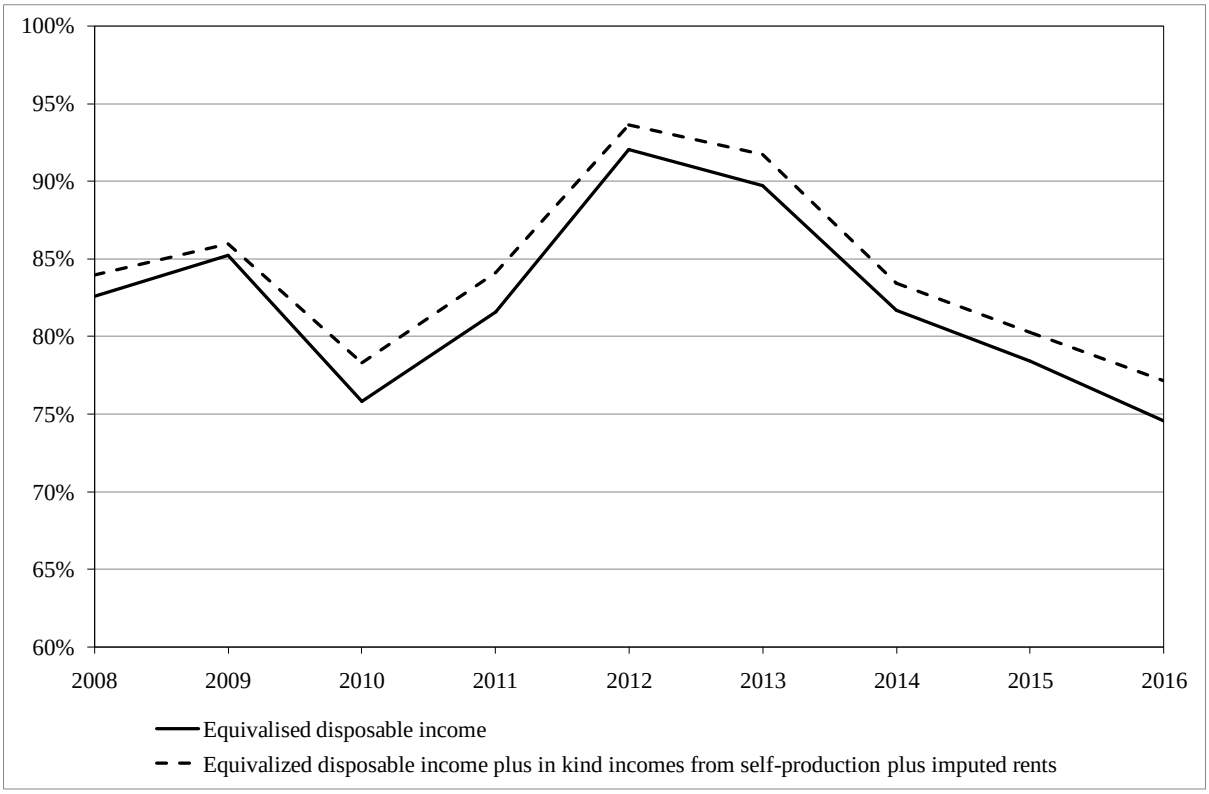

Source: own elaborations on EUSILC data.

**Figure 2**
**Relative level of farm households' income.**
**Ratio of incomes of narrow farm households over incomes of other self-employed households.**
**Whole EU and groups of countries. Years 2008-2016.**




Source: own elaborations on EUSILC data.

**Figure 3**
**Farm to non-farm income ratio and income differences.**
**Covariate matching estimates with alternative income definitions.**
**Whole EU. Euro 2015 PPP.**




Source: own elaborations on EUSILC data.

## Appendix

*Farm household definitions*

We first identify a sub-sample of self-employed individuals, since farm income is generated from self-employment. Among self-employed individuals, farmers are those working in agriculture. All households including a self-employed member compose the sub-sample of self-employed households. Within this sub-sample farm households can be identified according to two definitions. The first is a broad definition referring to all families that have at least one self-employed member working in agriculture. The second is the narrow definition of the "agricultural household sector" (United Nations, 2012): it considers as farm households only those with a farm income that is the main source of income (i.e. at least half of the total household income). The two definitions are generally employed to investigate different aspects of the farm problem but a focus on narrow farm households give policy makers a more informative picture on the sector which is the scope of the present paper.

Farm household in a broad sense are identified within the sample of all self-employed families as those earning at least some income from farming. Non-farm households are thus defined by simply excluding broad farm households from the sample of self-employed. Narrow farm households are identified within the broad farm households group as the families whose main source of income (i.e. at least 50% of total household income) is given by the self-employed income from farming. In the analysis the average income of narrow farm households is compared with the average income of narrow non-farm households, i.e. for which self-employed labour is at least 50% of total households income. Figure A.1 summarize the identification of households groups considered in the analysis. Regression Adjusted and Covariance Matching estimates compare the average income of narrow farm households (group A) with the average income of narrow, non-farm households (group C).

PLACE FIGURE A.1 HERE

Table A.1 reports the sample size and the corresponding population of self-employed households represented for every year of the time series, when considering the narrow definition of farm households, which is the main focus of our analysis.

*How farm households are identified within the EUSILC sample.*

We now go in details on how we identify within the EUSILC dataset the observations corresponding to the farm and nonfarm households groups. First, we identify self-employed individuals, since farm income is generated by self-employment. We use the EU-SILC variable PL031, which reports the self-defined current economic status. Both part-time and full-time working individuals are considered. Once self-employed subjects are identified, we need to screen among them those who work in agriculture. Farmers are identified using two variables: the ISCO-88 (PL050 variable before 2011 and PL051 variable after 2011) and the NACE classifications (PL111 variable) used at EU-level for both economic and social statistics. While the first is useful to identify the individual main occupation, the second is needed to identify the sector in which the individual is employed. Two simple rules are used in our work to identify farmers. First, among the self-employed, individuals are classified as farmer if they respond to the ISCO variable that they are market-oriented skilled agricultural workers (code 61), subsistence farmers, fishers, hunters and gatherers (code 63), agricultural, forestry and fishery labourers (code 92). Second, they are farmers also if they respond to the NACE variable that they work in the agricultural sector (classification A) and to the ISCO variable that they are production and specialized services manager (code 13) or personal sales workers (code 51). Some corrections are needed for countries whose ISCO variable is coded only with one digit (Malta, Slovakia and Germany), but the same criteria above apply except that those who respond that their main occupation is 1, 5 and 9 are not included.

Once farmers are identified, we can move to the identification of farm households, as well as their corresponding groups of nonfarm households.

The narrow definition implies the computation of income figures at the household level, in particular the totals of self-employed incomes. The dataset collects both gross and net individual self-employed income (PY050G/PY050N). In this stage of farm households identification, we replace negative values of self-employed income with random values among the lower quartile of the distribution (Van Kerm, 2007). We consider the net self-employed income except for some countries that only record gross income data. We sum individual values to get household values. Once we have the total of self-employed income at the household level, we identify self-employed households as those families that have a total self-employed income that is equal or greater than the half of the total disposable income, namely those families where the main source of income comes from self-employed labour. Also in this case, we prefer net figures but in some countries we must rely on gross values. Here also we apply the techniques suggested in Van Kerm (2007). Among these families, narrow farm households are those whose main source of income (more than 50% of total household income) is self-employed labour in agriculture. Narrow farm households are compared with narrow, strictly non-farm self-employed, i.e., households mainly relying on self-employed income (at least 50% of THI) earned in sectors different from agriculture.

*Testing for endogeneity of data*

Our estimates of the income gap between farm and non-farm households takes into account a set of observable characteristics widely accepted as determinants of income level. However some other unmeasurable and/or unmeasured factors could affect the income and/or the decision of being farmer. Before proceeding with estimates we exploited the information included in the EUSILC database to test if the presence of endogeneity would be likely to bias our results.

To account for unobservable characteristics that might generate endogeneity issues, a common approach is to consider variables which affect the choice of the sector of employment but are not likely to affect income level. The family background in the study of intersectoral income gap is widely used in the literature (Trostel et al., 2002; Pons and Gonzalo 2003; Hoogerheide et al., 2012; Danzer 2013; Gong, 2019). The use of the parental sector of employment as an instrumental variable in testing the presence of endogeneity is a possible practical solution even though still subject to discussion. Farm businesses are often passed from one generation to the next because the agricultural sector is typified by a strong heredity (Haagsma and Koning, 2005). Some countries consider agriculture to be a "closed profession" (Symes, 1990). The most common way of entry to farming is therefore succession in the family business (Zagata and Sutherland, 2015).

In the 2011 wave only of the EUSILC survey, a special module on "Intergenerational transmission of disadvantages" includes detailed information on parents' education, jobs (including sectors of employment) and income. Thus, we created a dummy variable if at least one of the two parents was a farmer. Despite we cannot exclude that the possibility that being the children of a farmer could be an endogenous variable, affecting both the decision of being a farmer and the income level, several reasons could be used also to support the exogeneity of this instruments. First of all, in a developed context as the EU it is increasingly difficult to consider farming families as a separate "social group" and the people born in farming families as different by nature in their the ability to earn an income. Moreover, modern agriculture is widely based on formal knowledge that can be acquired also by people from different backgrounds (such as big data and remote control devices: see for example Gebbers and Adamchuk 2010) as well as advanced and innovative supply chain managing practices (Randelli and Rocchi 2017).

We checked for the presence of endogeneity estimating a bivariate recursive mixed

model that employs a multi-equation setting (Roodman, 2011). Once the bivariate recursive model is estimated, we similarly run separately the two models, assuming that the correlation among errors is zero. A likelihood ratio test (LR test) is used under the null hypothesis that the model with the correlated errors and the model with the restriction that the correlation between the two errors is equal to zero are nested. The null hypothesis cannot be rejected with a LR chi square of 0.44 (p-value = 0.5053). Such result suggests that there is no endogeneity in our data. Although this cannot be considered as a conclusive evidence of the absence of relevant unobservables, the rejection of the endogeneity test gives us a greater confidence that the results of the RA model and the CM estimates are likely to not be biased. Although the test cannot be replicated in the other years of the observed period, since the relationship between farming decision and income determination can be considered a structural feature of the sector and is unlikely to change in the short run, it seems safe to assume that the results for year 2011 can be extended to the whole series 2008-2016.

*Additional tables*

**Table A.1**
**Sample size and population represented of farm and non-farm households.**
**EU-SILC. Years 2008 – 2016**

| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Total EU* | | | | |
| Farm | | | | | | | | | |
| Sample | 2,425 | 2,270 | 2,222 | 2,240 | 2,303 | 2,246 | 2,363 | 2,539 | 2,382 |
| Population | 1,514,323 | 1,467,943 | 1,508,755 | 1,574,174 | 1,628,919 | 1,550,323 | 1,659,221 | 1,699,704 | 1,437,766 |
| Nonfarm | | | | | | | | | |
| Sample | 11,161 | 11,001 | 10,559 | 10,325 | 10,194 | 9,784 | 10,047 | 10,453 | 8,428 |
| Population | 10,479,283 | 10,381,454 | 10,345,336 | 10,348,016 | 10,383,348 | 10,353,695 | 10,531,616 | 10,646,365 | 7,979,626 |
| | | | | | *Central Eastern* | | | | |
| Farm | | | | | | | | | |
| Sample | 940 | 1,000 | 1,001 | 1,005 | 1,045 | 1,055 | 1,071 | 1,043 | 1,046 |
| Population | 632,545 | 680,329 | 741,888 | 731,699 | 768,027 | 792,606 | 831,687 | 825,179 | 854,047 |
| Nonfarm | | | | | | | | | |
| Sample | 2,695 | 2,748 | 2,656 | 2,732 | 2,607 | 2,361 | 2,402 | 2,346 | 2,468 |
| Population | 1,645,275 | 1,701,929 | 1,747,062 | 1,742,859 | 1,790,771 | 1,721,570 | 1,665,812 | 1,716,411 | 1,670,549 |
| | | | | | *Mediterranean* | | | | |
| Farm | | | | | | | | | |
| Sample | 629 | 624 | 608 | 557 | 534 | 540 | 618 | 869 | 896 |
| Population | 460,304 | 465,979 | 445,256 | 399,872 | 373,811 | 407,585 | 398,991 | 403,357 | 264,228 |
| Nonfarm | | | | | | | | | |
| Sample | 5,044 | 4,971 | 4,651 | 4,423 | 4,391 | 4,259 | 4,479 | 4,922 | 2,783 |
| Population | 4,723,770 | 4,626,253 | 4,639,929 | 4,389,447 | 4,504,938 | 4,391,430 | 4,496,392 | 4,294,476 | 1,486,144 |
| | | | | | *Western Continental* | | | | |
| Farm | | | | | | | | | |
| Sample | 856 | 646 | 613 | 678 | 724 | 651 | 674 | 627 | 440 |
| Population | 421,474 | 321,636 | 321,611 | 442,603 | 487,081 | 350,132 | 428,544 | 471,168 | 319,491 |
| Nonfarm | | | | | | | | | |
| Sample | 3,422 | 3,282 | 3,252 | 3,170 | 3,196 | 3,164 | 3,166 | 3,185 | 3,177 |
| Population | 4,110,238 | 4,053,272 | 3,958,346 | 4,215,710 | 4,087,638 | 4,240,695 | 4,369,413 | 4,635,478 | 4,822,932 |

Source: own elaboration on EUSILC data

**Table A.2**
**Average income differentials between farm and non-farm households in the EU**
**Regression adjusted and covariate matching estimates.**
**Years 2008-2016. Euro 2015 PPP (Standard errors in parentheses)**

| | Estimated income differential | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2008 | | 2009 | | 2010 | | 2011 | | 2012 | | 2013 | | 2014 | | 2015 | | 2016 | |
| Raw mean values | -14,876.98 | *** | -15,109.31 | *** | -14,410.63 | *** | -13,616.88 | *** | -10,378.69 | *** | -11,893.53 | *** | -11,737.63 | *** | -11,224.11 | *** | -14,924.78 | *** |
| | (1,068.15) | | (696.68) | | (670.37) | | (662.37) | | (629.64) | | (845.95) | | (772.06) | | (778.65) | | (1,089.71) | |
| Regression with covariates | -4,485.97 | *** | -5,268.40 | *** | -6,135.71 | *** | -5,487.27 | *** | -5,185.49 | *** | -5,794.69 | *** | -5,792.25 | *** | -5,621.34 | *** | -8,046.30 | *** |
| | (940.64) | | (651.82) | | (650.38) | | (628.40) | | (644.54) | | (892.53) | | (748.81) | | (758.09) | | (1,405.94) | |
| Regression with covariates and country dummies | -2,162.30 | ** | -2,083.55 | *** | -2,694.87 | *** | -2,828.48 | *** | -1,152.62 | * | -1,421.72 | | -2,050.18 | ** | -3,312.11 | *** | -4,047.06 | *** |
| | (975.39) | | (685.92) | | (712.28) | | (634.06) | | (621.97) | | (906.87) | | (842.46) | | (867.70) | | (1,056.44) | |
| Covariate Matching | -2,948.90 | | -2,097.92 | *** | -3,485.13 | *** | -2,713.81 | *** | -1,087.47 | ** | -1,323.52 | ** | -2,569.57 | *** | -3,249.11 | *** | -3,408.86 | *** |
| | (2,277.34) | | (470.55) | | (553.28) | | (986.04) | | (434.32) | | (533.97) | | (462.33) | | (802.01) | | (710.20) | |

* p< 0.10, ** p < 0.05, *** p < 0.01
Source: own elaboration of on EUSILC data

**Table A.3**
**Extended income differential between farm and non-farm self-employed households.**
**Regression adjusted estimates.**
**Whole EU and country groups. Years 2008 - 2016. Euro 2015 PPP (Standard errors in parentheses)**

| | Estimated income differential | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2008 | | 2009 | | 2010 | | 2011 | | 2012 | | 2013 | | 2014 | | 2015 | | 2016 | |
| | Equivalised disposable income | | | | | | | | | | | | | | | | | |
| Whole EU | -2,162.30 | ** | -2,083.55 | *** | -2,694.87 | *** | -2,828.48 | *** | -1,152.62 | * | -1,421.72 | | -2,050.18 | ** | -3,312.11 | *** | -4,047.06 | *** |
| | (975.39) | | (685.92) | | (712.28) | | (634.06) | | (621.97) | | (906.87) | | (842.46) | | (867.70) | | (1,056.44) | |
| Central Eastern | -645.45 | * | -1,484.37 | *** | -1,248.00 | *** | -1,288.50 | *** | -1,193.96 | *** | -2,056.26 | *** | -1,590.10 | *** | -1,745.81 | *** | -2,403.66 | *** |
| | (342.50) | | (389.22) | | (337.84) | | (339.77) | | (339.59) | | (416.62) | | (316.33) | | (375.10) | | (376.98) | |
| Mediterranean | -1,801.59 | ** | -1,323.61 | | -2,457.79 | *** | -2,632.79 | *** | 411.04 | | -681.29 | | -717.03 | | -1,600.92 | ** | 970.59 | |
| | (724.66) | | (903.05) | | (802.59) | | (886.58) | | (1,002.88) | | (733.09) | | (804.68) | | (736.74) | | (1,597.29) | |
| Western Continental | -5,705.73 | * | -5,276.08 | ** | -8,657.24 | *** | -6,362.01 | *** | -3,700.08 | ** | -4,035.52 | | -7,270.28 | *** | -7,301.37 | *** | -11,163.67 | *** |
| | (3,189.59) | | (2,304.07) | | (2,448.86) | | (1,820.82) | | (1,601.64) | | (3,366.79) | | (2,743.20) | | (2,704.82) | | (2,682.68) | |
| | Equivalized disposable income plus in kind incomes from self-production | | | | | | | | | | | | | | | | | |
| Whole EU | -2,281.84 | ** | -2,265.04 | *** | -2,739.39 | *** | -2,718.61 | *** | -1,042.03 | | -1,431.39 | | -2,113.27 | ** | -3,406.61 | *** | -4,204.70 | *** |
| | (980.13) | | (706.82) | | (735.07) | | (649.27) | | (638.02) | | (920.42) | | (860.75) | | (889.65) | | (1,120.18) | |
| Central Eastern | -871.83 | ** | -1,454.69 | *** | -1,231.52 | *** | -1,285.46 | *** | -1,124.61 | *** | -2,106.05 | *** | -1,633.12 | *** | -1,776.07 | *** | -2,370.99 | *** |
| | (351.72) | | (398.16) | | (349.18) | | (350.87) | | (351.14) | | (430.52) | | (329.78) | | (382.68) | | (380.44) | |
| Mediterranean | -1,717.72 | ** | -1,196.91 | | -2,213.78 | *** | -2,491.92 | *** | 249.78 | | -393.42 | | -544.31 | | -1,462.24 | * | 893.04 | |
| | (747.42) | | (926.72) | | (827.90) | | (921.12) | | (1,040.42) | | (752.29) | | (823.73) | | (779.45) | | (1,637.37) | |
| Western Continental | -5,928.21 | * | -6,044.48 | *** | -8,942.53 | *** | -6,010.58 | *** | -3,206.03 | * | -4,035.30 | | -7,499.86 | *** | -7,534.26 | *** | -11,488.44 | *** |
| | (3,197.47) | | (2,345.14) | | (2,528.58) | | (1,864.12) | | (1,639.37) | | (3,382.98) | | (2,792.07) | | (2,741.32) | | (2,816.39) | |
| | Equivalized disposable income plus imputed rents | | | | | | | | | | | | | | | | | |
| Whole EU | -1,925.64 | ** | -1,863.16 | *** | -2,481.94 | *** | -2,599.96 | *** | -941.36 | | -1,232.44 | | -1,866.61 | ** | -3,187.59 | *** | -4,006.69 | *** |
| | (973.28) | | (685.89) | | (709.61) | | (631.22) | | (621.34) | | (907.05) | | (842.21) | | (867.34) | | (1,099.30) | |
| Central Eastern | -373.33 | | -1,212.97 | *** | -1,009.87 | *** | -1,007.09 | *** | -954.63 | *** | -1,853.39 | *** | -1,399.56 | *** | -1,628.10 | *** | -2,253.04 | *** |
| | (352.22) | | (397.32) | | (347.16) | | (343.33) | | (340.12) | | (422.30) | | (325.49) | | (374.36) | | (376.89) | |
| Mediterranean | -1,438.59 | ** | -1,022.34 | | -2,198.49 | *** | -2,344.96 | *** | 605.56 | | -556.00 | | -567.04 | | -1,437.20 | * | 1,065.38 | |
| | (719.76) | | (896.11) | | (800.00) | | (881.27) | | (1,005.73) | | (733.09) | | (801.90) | | (734.52) | | (1,595.31) | |
| Western Continental | -5,711.53 | * | -5,262.86 | ** | -8,561.11 | *** | -6,245.73 | *** | -3,530.76 | ** | -3,861.43 | | -7,122.20 | *** | -7,208.30 | *** | -11,302.08 | *** |
| | (3,180.68) | | (2,292.40) | | (2,436.14) | | (1,807.97) | | (1,600.85) | | (3,365.18) | | (2,737.89) | | (2,703.39) | | (2,759.21) | |

* p< 0.10, ** p < 0.05, *** p < 0.01

Source: own elaboration of on EUSILC data

**Table A.4**
**Extended income differential between farm and non-farm self-employed households.**
**Covariate matching estimates.**
**Whole EU and country groups. Years 2008 - 2016. Euro2015 PPP (Standard errors in parentheses)**

| | Estimated income differential | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2008 | | 2009 | | 2010 | | 2011 | | 2012 | | 2013 | | 2014 | | 2015 | | 2016 | |
| | Equivalized disposable income. | | | | | | | | | | | | | | | | | |
| Whole EU | -2,948.90 | | -2,097.92 | *** | -3,485.13 | *** | -2,713.81 | *** | -1,087.47 | ** | -1,323.52 | ** | -2,569.57 | *** | -3,249.11 | *** | -3,408.86 | *** |
| | (2,277.34) | | (470.55) | | (553.28) | | (986.04) | | (434.32) | | (533.97) | | (462.33) | | (802.01) | | (710.20) | |
| Central Eastern | -,977.01 | *** | -1,870.83 | *** | -1,677.43 | *** | -1,612.67 | *** | -1,163.80 | *** | -1,277.61 | *** | -1,637.74 | *** | -1,513.79 | *** | -2,013.72 | *** |
| | (255.01) | | (220.01) | | (220.30) | | (215.93) | | (179.78) | | (246.23) | | (253.78) | | (257.71) | | (282.85) | |
| Mediterranean | -1,212.38 | ** | -1,764.98 | *** | -2,334.92 | *** | -1,956.89 | *** | 280.24 | | -1,622.45 | *** | -1,849.84 | *** | -2,722.36 | *** | 361.82 | |
| | (566.80) | | (673.75) | | (550.80) | | (592.93) | | (848.84) | | (588.44) | | (691.39) | | (533.23) | | (607.48) | |
| Western Continental | -7,777.12 | | -3,061.29 | * | -9,218.02 | *** | -4,992.97 | | -2,032.91 | | -1,106.46 | | -5,080.81 | *** | -4,934.06 | * | -10,982.07 | *** |
| | (8,144.64) | | (1,818.60) | | (2,431.24) | | (3,449.63) | | (1,265.11) | | (2,217.19) | | (1,615.54) | | (2,569.94) | | (2,949.05) | |
| | Equivalized disposable income plus in kind incomes from self-production | | | | | | | | | | | | | | | | | |
| Whole EU | -3,075.72 | ** | -2,265.54 | *** | -3,518.24 | *** | -2,633.96 | *** | -,983.15 | ** | -1,202.43 | ** | -2,635.11 | *** | -3,364.54 | *** | -3,433.61 | *** |
| | (1,308.30) | | (467.61) | | (,566.06) | | (1,001.10) | | (447.71) | | (,539.72) | | (479.92) | | (,822.98) | | (,733.05) | |
| Central Eastern | -1,119.00 | *** | -1,859.77 | *** | -1,705.44 | *** | -1,641.91 | *** | -1,183.56 | *** | -1,339.99 | *** | -1,681.17 | *** | -1,548.08 | *** | -1,932.03 | *** |
| | (267.91) | | (227.43) | | (229.51) | | (221.25) | | (185.51) | | (245.81) | | (255.02) | | (271.71) | | (287.60) | |
| Mediterranean | -1,343.71 | ** | -1,854.90 | *** | -2,207.11 | *** | -1,771.74 | *** | 33.09268 | | -1,530.96 | ** | -1,968.95 | *** | -2,849.56 | *** | 106.3285 | |
| | (,587.99) | | (,702.58) | | (,566.90) | | (,624.09) | | (,855.87) | | (,605.51) | | (,713.89) | | (554.81) | | (,615.47) | |
| Western Continental | -7,771.86 | * | -3,686.21 | ** | -9,450.54 | *** | -4,810.64 | | -1,434.51 | | -,530.01 | | -5,134.00 | *** | -5,178.39 | ** | -11,221.35 | *** |
| | (4,628.58) | | (1,776.06) | | (2,471.98) | | (3,498.46) | | (1,311.51) | | (2,238.81) | | (1,677.17) | | (2,638.88) | | (3,051.26) | |
| | Equivalized disposable income plus imputed rents | | | | | | | | | | | | | | | | | |
| Whole EU | -2,771.24 | ** | -1,972.10 | *** | -3,366.48 | *** | -2,533.43 | ** | -,912.79 | ** | -1,186.44 | ** | -2,483.71 | *** | -3,125.52 | *** | -3,294.59 | *** |
| | (1,301.17) | | (451.48) | | (,552.45) | | (,986.38) | | (434.54) | | (,537.18) | | (470.61) | | (,801.88) | | (,714.52) | |
| Central Eastern | -,824.63 | *** | -1,718.73 | *** | -1,580.64 | *** | -1,375.09 | *** | -,935.20 | *** | -1,154.41 | *** | -1,596.87 | *** | -1,386.07 | *** | -1,858.75 | *** |
| | (273.31) | | (245.71) | | (237.21) | | (232.63) | | (181.11) | | (266.57) | | (316.11) | | (258.08) | | (283.09) | |
| Mediterranean | -,869.30 | | -1,504.13 | ** | -2,086.04 | *** | -1,762.80 | *** | 401.4645 | | -1,498.47 | ** | -1,694.07 | ** | -2,565.84 | *** | 450.0566 | |
| | (,563.18) | | (,673.44) | | (,542.16) | | (,592.00) | | (,854.74) | | (,589.05) | | (,691.32) | | (533.30) | | (,607.08) | |
| Western Continental | -7,749.68 | * | -3,130.70 | * | -9,211.66 | *** | -4,898.05 | | -1,882.56 | | -,928.60 | | -4,970.48 | *** | -4,852.51 | * | -10,956.72 | *** |
| | (4,607.00) | | (1,697.57) | | (2,421.84) | | (3,449.18) | | (1,262.53) | | (2,218.91) | | (1,614.86) | | (2,569.18) | | (2,949.07) | |

* p< 0.10, ** p < 0.05, *** p < 0.01
Source: own elaboration of on EUSILC data

**Figure A.1**
**Definition of farm and nonfarm households**