Farm level impacts of abolishing the CAP direct payments: An assessment using the IFM-CAP model

Pavel Ciaian[1*], Maria Espinosa[1], Kamel Louhichi[1,2], Angel Perni[1], Sergio Gomez y Paloma[1]

*[1] European Commission, DG Joint Research Centre, Spain***

[2]INRA – UMR Economie Publique, Thiverval-Grignon, France

** Corresponding author: Pavel.Ciaian@ec.europa.eu*

Paper prepared for presentation for the 162nd EAAE Seminar
The evaluation of new CAP instruments: Lessons learned and the road ahead

April 26-27, 2018
Corvinus University of Budapest
Budapest, Hungary

*** The authors are solely responsible for the content of the paper. The views expressed are purely those of the authors and may not in any circumstances be regarded as stating an official position of the European Parliament or the European Commission.*

Farm level impacts of abolishing the CAP direct payments: An assessment using the IFM-CAP model

Abstract:

This paper assesses the impacts of abolishing the CAP direct payments using the IFM-CAP (Individual Farm Model for CAP Analysis) model. FM-CAP is a static positive programming model developed to capture the full heterogeneity of EU farms in terms of policy representation and impacts. Simulation results show that a small set of farm-types experience an increase in income due to the improvement in prices and yields (e.g. specialist granivores and farms specialised in other field crops), while farms that are most CAP subsidy dependent (e.g. specialist cattle, specialist COP and small farms) lose income by more than 12% at aggregate EU level. As much as 77% of all farms lose income if direct payments are removed, while the proportion of most income vulnerable farms almost doubles.

***Keywords**: Common Agricultural Policy; Farm Level Model; Positive Mathematical Programming; EU-wide; FADN (Farm Accountancy Data Network)*

1. Introduction

Over the last years there has been an intensive debate among policy makers, stockholders and academics on the future of the Common Agricultural Policy (CAP). Several recent events at the EU level (e.g. Brexit) and global scale (e.g. migration, security) have put the CAP under pressure for further reform. Given that the CAP budget represents a significant share of the total EU budget (37% in 2017), these developments are expected to reduce the available financial resources for the CAP. For example, since the UK is a net contributor to the EU budget, the *Brexit* is expected to potentially reduce the CAP budget. Further, the concerns about migration and global security may divert EU resources to these priorities in the detriment of the CAP. Reflecting on these developments, European Commission proposed up to 30% cut of the CAP budget in the EU Multi-Financial Framework after 2020 (European Commission, 2018).

Apart from the pressures on the CAP budget cut, there is an intense on-going debate about the effectiveness of direct payments[1] – which represent the main bulk (72%) of the CAP expenditures – in addressing policy objectives such as farmers' income support. First, there is the concern that an excessive share of direct payments benefits big farms[2] largely determined by the allocation mechanism of direct payments based on land area (Matthews, 2017; European Commission, 2017). Second, a substantial share of direct payments could be leaked to landowners instead of farmers because of their capitalization into higher land values. The empirical studies show that the share of direct payments potentially leaked to landowners could

[1] Under the current CAP, the direct payment include decoupled payments (66%) (Basic Payment Scheme or Single Area Payment Scheme), redistributive payment (4%), Voluntary Coupled support (10%) and Young Farmer Scheme (1.2%). The rest (18.8%) to the direct payments correspond to the greening payments.

[2] According to European Commission (2017) around 80% of direct payments goes to 20% of farms in EU

be greater than 20% (e.g.Kilian et al. 2012; Van Herck and Vranken 2013; Michalek, Ciaian and Kancs 2014; O'Neill and Hanrahan 2016; Klaiber, Salhofer and Thompson 2017; Ciaian et al., 2018). These income distributional issues pose the questions of what is the actual farmers' dependency on the direct payments and farmers' vulnerability to potential CAP budget reduction or elimination.

These CAP pressures raise the question to what extend EU farming sector will be affected by a radical CAP reform. We attempt to address this question by analysing the implications for the EU farming sector of a scenario which assumes the abolition of direct payments as adopted by the 2013 CAP reform. The results of the analysis will help assessing the vulnerability and viability of the European farming sector under this drastic CAP reform. The available literature mainly focuses on analysing rather marginal changes (reforms) of CAP. A vast majority of papers analyse the CAP reform proposed or already adopted by EU (Van Zeijts *et al.*, 2011; Gocht et al. 2013; Solazzo *et al.*, 2014; Cortignani and Dono, 2015; Vosough-Ahmadi *et al.*, 2015; Louhichi et al. 2018a). There are significantly less studies available in the literature that analyse a more substantial CAP reform compared to the status-quo situation such as the elimination of the CAP payments (Vrolijk *et al.* 2010; Latruffe *et al.*, 2013.; Raggi *et al.*, 2013). All these studies are based either on a static behavio, therefore not considering farmers decisions on land allocation (Vrolijk *et al.* 2010) or focuses on specific regions and are based on farmers declarations of intentions (Latruffe *et al.*, 2013; Raggi *et al.*, 2013).

We employ the IFM-CAP (Individual Farm Model for Common Agricultural Policy Analysis) model in our analysis. The main advantage of IFM-CAP is that it provides a comprehensive assessment of farm-specific policies by accounting for the full heterogeneity and behaviour of EU commercial farms in terms of policy representation and impacts enabling the assessment of the distributional impacts of policies across the farm population. These features of IFM-CAP allow us to analyse the extent of the economic impacts of CAP across different farm typologies and the distributional effects across farm population. These characteristics of IFM-CAP are highly relevant when analysing the impacts of CAP direct payments because the eligibility and the magnitude of direct payments are farm specific in many Member States (MS) as well as they are conditional on pursuing certain environmental farm practices (i.e. greening measures) that depend on farm production structure (Louhichi *et al.*, 2017a; Louhichi *et al.*, 2018a; Louhichi *et al.*, 2018b). Although several farm modelling approaches have been used in the literature, they cannot capture the full extent of CAP impacts at EU level. While the representative farm models are subject to strong limitations because they cannot model policies for which eligibility depends on individual farm characteristics (Van Zeijts *et al.*, 2011; Gocht *et al.*, 2013), the available individual (real) farm models are usually applied only to selected Member States (MSs)/regions or to specific agricultural sectors (e.g. Solazzo *et al.*, 2014; Cortignani and Dono, 2015; Vosough-Ahmadi *et al.*, 2015). For these reasons, most of the models used in the literature fail to capture distributional EU-wide CAP effects across EU farming sector.

The paper is structured as follows. The following section introduces the IFM-CAP model. The third section summarises the assumptions of scenarios simulated in the paper. The fourth section presents the results, followed by the concluding section.

2. The IFM-CAP model

The IFM-CAP model is a farm-level model designed for the economic and environmental analysis of the European agriculture. The main advantage of IFM-CAP is that it models a large sample of individual farms in the EU, which allows capturing the farm heterogeneity to a degree sufficient to apprehend the impacts of the direct payments as introduced by the 2013 CAP reform. The micro level detail of IFM-CAP is important because direct payments are farm-specific and their magnitude dependents on the implementation approach applied by each MS (e.g. full *versus* partial convergence of direct payments). Further, farmers receiving direct payments need to adopt greening measures. The greening measures target land allocation at farm level implying that their adoption and impacts largely depend on farm-specific characteristics (size, specialisation, localisation, etc.). This poses challenges for policy evaluation and raises the need for the application of a micro model. The advantage of IFM-CAP compared to other models used for CAP impact analysis is that it combines an EU-wide geographical coverage and the use of individual farm data that allows simulation of policy impacts across all EU farming systems and regions (Louhichi *et al.*, 2017a; Louhichi *et al.*, 2018a).

The IFM-CAP model is a static positive mathematical programming model. The model assumes that farmers maximise their expected utility subject to resource (arable and grass land and feed) endowments and policy constraints such as CAP greening restrictions (Louhichi *et al.,* 2018a). Farmers expected utility is defined following the mean-variance (E-V) approach (Markowitz, 2014) with a CARA (Constant Absolute Risk Aversion) specification (Pratt, 1964). According to this approach, expected utility is defined as the expected income and the associated income variance. Effectively, it is assumed that farmers select a production plan which minimises the variance of income caused by a set of stochastic variables for a given expected income level (Arribas *et al.,* 2017).

Farmer's expected income is defined as the sum of expected gross margins minus a non-linear (quadratic) activity-specific function. The gross margin is the total revenue including sales from agricultural products and direct payments (coupled and decoupled payments) minus the accounting variable costs of production activities. Total revenue is calculated using expected prices and yields assuming adaptive expectations (based on past three observations with declining weights). The expected accounting costs include costs of seeds, fertilisers and soil improvers, crop protection, feeding and other specific costs (following the same approach as with expected revenues). The quadratic activity-specific function is a behavioural function introduced to calibrate the farm model to an observed base year, as usually done in positive programming models. This function intends to capture the effects of factors that are not explicitly included in the model, such as farmers' perceived costs of capital and labour, or model misspecifications (Paris and Howitt, 1998; Heckelei, 2002; De Frahan *et al.,* 2007). Regarding the income variance, we opted for considering uncertainty in revenues, but without differentiating between sources of uncertainty (Arribas *et al.*, 2017).

The general mathematical formulation of the IFM-CAP model can be written as follows (Louhichi *et al.*, 2018a):

Maximise $$\mathrm{E}(U) = E[p \circ y]'x - Cx + s'x + et - d'x - \frac{1}{2}x'Qx - \frac{\varphi}{2}x'\Sigma x \qquad (8)$$

s.t.

$$Ax \leq b\,[\rho] \qquad (9)$$

$$x \geq 0 \qquad (10)$$

where $E(U)$ is the farm expected utility to be maximized, x is the I×1 vector of unknown activity levels, p is the I×1 vector of activity prices, y is the I×1 vector of activity yields, s is the I×1 vector of coupled payments, C the I×K matrix of average observed variable costs, e is the constant decoupled payment per eligible hectare, t is the constant eligible area for decoupled payments, d is the I×1 vector of the linear part of the behavioural activity function, Q is the I×I symmetric, positive (semi-) definite matrix of the quadratic part of the behavioural activity function, φ is the farmer's constant absolute risk aversion coefficient and Σ is the I×I symmetric, positive (semi-) definite matrix of the variance-covariance activity revenues, A is the M×I matrix of technical coefficients, b is the M×1 vector of available resources and upper bounds to the policy constraints and ρ is the M×1 vector of the dual values associated with the resource constraints.

IFM-CAP is calibrated for the base year 2012 using individual farm-level data (i.e. multiple observations) and the Highest Posterior Density (HPD) approach with prior information on NUTS2[3] supply elasticities and dual values of resources (e.g. land rental prices). The calibration to the exogenous supply elasticities is performed in a non-myopic way, i.e., we take into account the effects of changing dual values on the simulation response (for more details see Louhichi *et al.*, 2018a).

The primary data source used to parameterize IFM-CAP is the individual farm-level data (83,292 farms observations for the base-year 2012) from the Farm Accountancy Data Network (FADN) database. The FADN is a European system of farm surveys that take place every year and collect structural and accountancy information on EU farms, such as farm structure and yield, output, land use, inputs, costs, subsidies, income, and financial indicators. The FADN data is unique in the sense that it is the only source of harmonized and representative farm-level microeconomic data for the whole European Union. Farms are selected to take part in the survey based on stratified sampling frames established for each EU region. The FADN survey does not, however, cover all farms in the EU, but only those which are of a size allowing them to rank as commercial farms. However, FADN represents a population of around 5,000,000 farms, covering approximately 90% of the total utilized agricultural area and accounting for more than 90% of the total agricultural production. The aggregate FADN data are publicly available. However, farm-level FADN data, which we employ in this study, are confidential and, for the purposes of this study, accessed under a special agreement. In order to cover the intensive data needs of IFM-

[3] NUTS2 refers to regions belonging to the second level of the Nomenclature of Territorial Units for Statistics of the European Union.

CAP, the FADN data is complemented by other external EU-wide data sources such as the European Farm Structure Survey (FSS), the CAPRI model database (Britz and Witzke, 2014) and Eurostat (Louhichi *et al.,* 2018b).

3. Policy scenario assumptions

3.1. Baseline

The baseline scenario represents the current CAP development until 2030 incorporating the dynamics of the market developments from the CAPRI baseline. The CAPRI baseline is developed in conjunction with the European Commission baseline. The European Commission constructs medium-term projections for the agricultural commodity markets on an annual basis. These projections present a consistent set of market and sectoral income prospects defined on the basis of specific policy and macroeconomic assumptions (Himics *et al.*, 2013; Britz and Witzke, 2014).

Four assumptions were adopted to construct the IFM-CAP baseline: (i) a continuation of the current CAP up to 2030; (ii) an adjustment of baseline prices and yields using regional growth rates from the CAPRI baseline; (iii) an assumed inflation rate of 1.9 per cent per year (consistent with the CAPRI baseline) for input costs and (iv) an adjustment of input costs to account for improvement in farm efficiency proxied by total factor productivity (European Commission 2016). The regional yield growth attempts to capture both technical change and input intensification effects and the regional price growth represents a nominal price projection. As the CAPRI growth rates of yields and prices are defined at NUTS2 level, we imposed the same growth rate on all farms belonging to the same NUTS2 region. All the other parameters (e.g. farm resource endowments and farm weighting factors) are assumed to remain unchanged up to 2030.

The IFM-CAP baseline assumes the implementation of the 2013 CAP reform. The direct payments considered in IFM-CAP are listed in Table 1. That is, IFM-CAP baseline includes Basic Payment Scheme (BPS) considering the internal convergence and Single Area Payments Scheme (SAPS), redistributive payment, degressivity/capping of direct payments, CAP greening, payments for Areas of Natural Constraint (ANC) and voluntary coupled support (VCS). Rural Development payments are not considered in this analysis and hence they are implicitly assumed unchanged.[4]

The baseline also includes national direct payments: Complementary National Direct Payments (CNDP), Transitional National Aid (TNA) and National Payments (NATIONAL). Even though national direct payments are not part of CAP, they are considered in baseline because they affect farm income. The Complementary National Direct Payments (CNDP) is the national aid granted to certain sectors in MS which joined the EU in 2004. With exception of Bulgaria, Croatia and Romania, since 2013, CNDP were substituted by Transitional National Aid (TNA). TNA are subject to a gradual reduction. Note, that these payments are not part of the CAP budget,

[4] For a more details on modelling direct payments and CAP greening in IFM-CAP see Louhichi *et al.* (2017a), Louhichi *et al.* (2018a) and Louhichi *et al.* (2018b).

however, the total amounts are regulated by the European Commission. Additionally, MS can grant National Payments (NATIONAL) to farmers[5].

3.2. 'NoCAP' scenario

The NoCAP scenario aims to analyse the potential impact of a radical shift in CAP priorities. It assumes a removal of direct payments which primarily represents the abolition of the policy objective to support farmers' income and environmental objectives associated with CAP greening measures. However, the national payments and the Complementary National Direct Payments are kept unchanged as in baseline given that they are not part of the CAP (Table 1).

Table 1: Policy assumptions in the IFM-CAP baseline and NoCAP scenario

Instrument	IFM-CAP Baseline - 2030	NoCAP scenario
Direct payments		
Decoupling (BPS)	BPS/SAPS	Removed
Coupled direct payment (VCS)	VCS according to the options notified by MSs up to 31/08/2015	Removed
Redistributive payment (RED)	Implemented	Removed
Young farmer scheme	Not implemented	Removed
Green payment (GREEN)	Green payment component and greening constraints implemented	Removed
Capping (CAPP)	Implemented	Removed
Areas of Natural Constraint (ANC)	Implemented (relevant only for Denmark)	Removed
National payments		
Complementary National Direct Payments/Transitional National Aid (CNDP)	Kept unchanged at base year level	Kept unchanged
National payments (NATIONAL)	Kept unchanged at base year level	Kept unchanged

IFM-CAP does not model market interactions. As a result, prices and yields are fixed in IFM-CAP. However, because production effects of the abolishment of direct payments might be substantial, we consider price and yield changes as simulated by the CAPRI model. The market feedback on prices and yields are taken from the CAPRI simulations done in the context of the Scenar-2030 study (M'Barek *et al.*, 2017). Similarly, as in IFM-CAP, the CAPRI scenario assumed removal of direct payments, however in CAPRI is considered as well the removal of Rural Development payments. It is important to highlight that in the CAPRI scenario, there are applied several assumptions regarding trade and climate policies that may also affect the simulated price/yields changes besides the removal of direct payments. More specifically, CAPRI scenario assumes the liberalisation of its trade policies with non-EU countries and the imposition of GHG emissions targets as part of the EU climate action (M'Barek *et al.*, 2017). The CAPRI

[5] FADN contains data for direct payments allocated both from National and EU budgets. The National and EU direct payments were disentangled based on the envelopes (ceilings) associated to EU funds.

price and yield changes under NoCAP scenario are reported in Table 2. Overall, the yields tend to decrease for most product aggregates. The exceptions are the group defined as "Other arable crops" as well as the beef meat activities. The production decrease induced by the yield drop causes crop prices to increase with the exception of cereals. Prices of most animal products reduce mainly driven by higher feed costs.

Table 2: CAPRI price and yield changes in EU in NoCAP scenario (% change relative to baseline)

	Yield	Producer price
Cereals	–2.9%	–0.4%
Oilseeds	–3.5%	7.9%
Other arable crops	10.0%	3.7%
Vegs & Permanent crops	–2.5%	3.4%
Dairy cows	–2.8%	11.9%
Beef meat activities	0.3%	–1.2%
Pig fattening	–3.4%	6.6%
Sheep & goat fattening	–1.7%	–1.8%
Poultry fattening	–2.7%	–1.5%

Source: Scenar-2030 report (M'Barek *et al.*, 2017)

4. Results

4.1. Farm income dependency of CAP payments in the baseline

Table 3 and Table 4 present (expected) income[6] and direct payments by farm specialisation and economic size class in baseline in EU-27.[7] Results show that the farm income varies substantially among the different farm-types in the EU. The highest income per hectare and per farm aggregated at EU-27 level is recorded in specialist horticulture farms due to the production of high-value products which tend to be labour intensive. The lowest per hectare income is observed for specialist COP and specialist cattle, while the lowest income per farm is on mixed livestock and permanent crop farms. Regarding farm size, as expected, larger farms have higher income per farm than smaller ones. Also income per hectare is positively correlated with farm size because larger economic size classes tend to be involved in production of activities that are more labour and input intensive than smaller farms.

The CAP direct payments vary between 158 EUR/ha for specialist wine farms and 357 EUR/ha for specialist olives farms in EU-27. The difference of direct payments per farm is wider due to the differences in farm structure and the eligibility criteria for subsidies. Farm specialisation receiving the lowest CAP payments per farm are specialist horticulture (1223 EUR/farm), while specialist COP receive the highest amount, 14321 EUR/farm. By farm size, the direct payments variation per hectare is smaller. As expected, larger farms have higher direct payments per farm

[6] In the result section income refers to gross margins defined as expected revenues plus direct payments minus variable costs.
[7] Croatia is not included in the analysis due to unavailability for FADN data for the base year.

than smaller ones. The biggest size class farms receive 60 times more direct payments than smallest size farm class (Table 3; Table 4).

The most CAP subsidy dependent farms are specialised in cattle breeding COP and olive production with the share of direct payments in income representing 26%, 24% and 21%, respectively. These farm types are expected to be most affected by the abolishment of the CAP. On the other hand, farm specialised in highly intensive sectors (specialist horticulture and specialist wine), which historically have benefit less from CAP subsidies, are less reliant on direct payments (i.e. the share of direct payments in income is below 4%). As expected, small and medium-sized farms (less than EUR 100,000 of Standard Output) are more dependent on CAP subsidies. CAP direct payments represent between 15% and 20% of total farm income in small and medium-sized farms, while for large farms (above EUR 100,000 of Standard Output) this share is between 7% and 9% (Table 3; Table 4). At individual level, for many farms CAP subsidies account for a substantial proportion of total income: around 32% of farms receive subsidies that account for more than 20% of their total incomes (Figure 1).

Table 3: Income and direct payments in the baseline by farm-specialisation in EU-27

Farm specialisation	Income		CAP direct payments		
	EUR/ ha	EUR/farm	EUR/ ha	EUR/farm	% in farm income
Mixed crops	4270	96239	209	4709	4.9
Mixed crops-livestock	1609	51258	217	6909	13.5
Mixed livestock	2416	34770	223	3208	9.2
Permanent crops	2666	29651	220	2446	8.2
Specialist cattle	919	47231	237	12206	25.8
Specialist COP	800	59359	193	14321	24.1
Specialist granivores	3285	121918	217	8065	6.6
Specialist horticulture	27400	171719	195	1223	0.7
Specialist milk	3617	134674	260	9670	7.2
Specialist olives	1733	19274	357	3966	20.6
Specialist orchards – fruits	4346	42676	188	1845	4.3
Specialist other fieldcrops	2208	87406	241	9562	10.9
Specialist sheep-goats	1246	50391	170	6868	13.6
Specialist wine	4470	58439	158	2064	3.5
EU-27	2081	69787	217	7292	10.4

Table 4: Income and direct payments in the baseline by farm-economic size in EU-27

Farm size (in thousands EUR)	Income		CAP direct payments		
	EUR/ ha	EUR/farm	EUR/ ha	EUR/farm	% in farm income
2 - < 8 EUR	1577	8891	215	1214	13.6
8 - < 25 EUR	1309	21258	212	3446	16.2
25 - < 100 EUR	1651	75118	215	9760	13.0
100 < 500 EUR	2510	268190	222	23714	8.8
>= 500 EUR	2937	992236	219	73848	7.4
EU-27	2081	69787	219	7292	10.4

Notes: The economic size classes are presented in 1000 EUR of Standard Output

Figure 1: Distribution of CAP direct payments as % of income across the farm-population in the baseline in EU-27

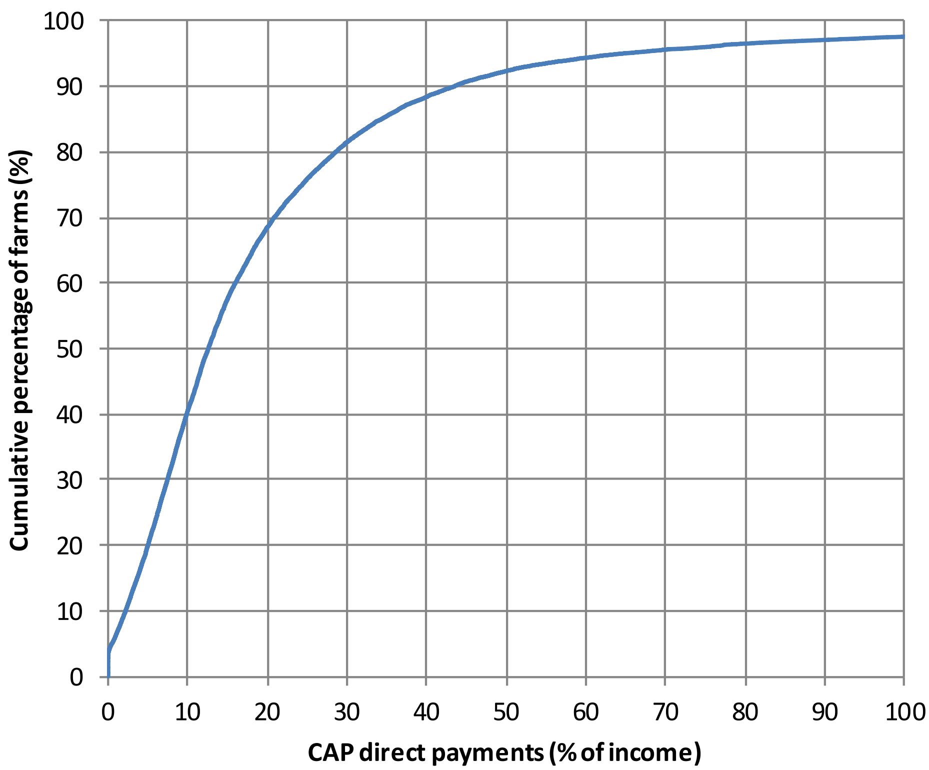


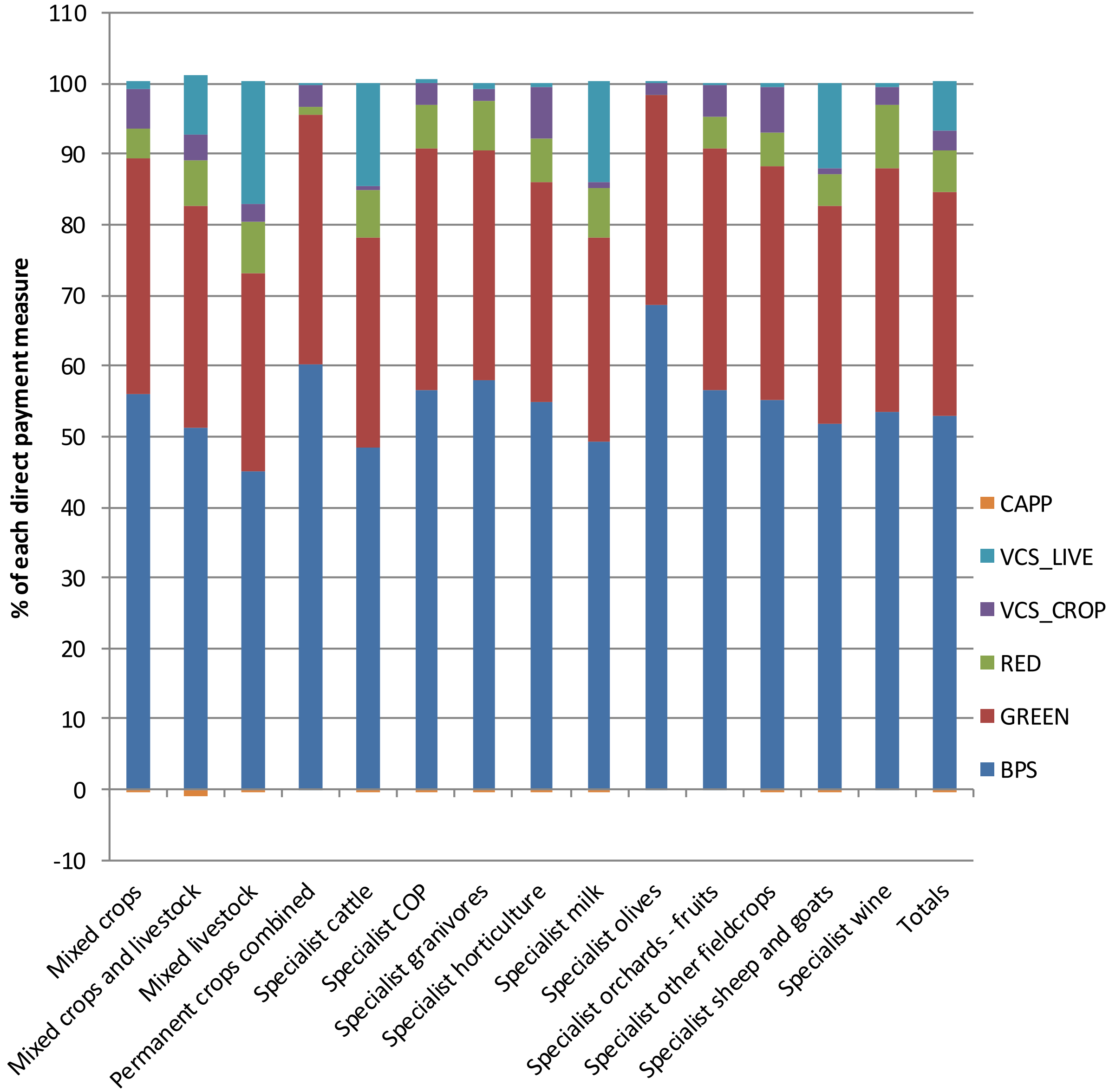
Figure 2 and Figure 3 show the composition of CAP direct payments by farm specialisspecialisationation and farm size in EU-27.[8] In general, farms specialised in crop production receive higher share of decoupled payments (BPS, GREEN, RED) in total value of direct payments (more than 94.5% of total CAP direct payments compared to 86% for livestock

[8] Areas of Natural Constraint (ANC) is not represented in Figure 2 and Figure 3 as they represent only minor share of total direct payments (less than 0.02%). Summing all the components the value is 100% (capping is considered as subsidies with a negative value).

farms). Also larger farms have a greater share of decoupled payments in total direct payments. Figure 3 shows the effects of capping (CAPP) which is affecting more the largest farms (-2.5 % of CAP direct payments), while it is almost negligible for the rest of the economic size classes. Capping has negative sign because it reduces direct payments to large farms. Note that the decoupled payment (BPS, GREEN, RED) are distributed based on land use independently of the production activity carried out on land and thus they are not expected to impact land allocation decisions of farmers.

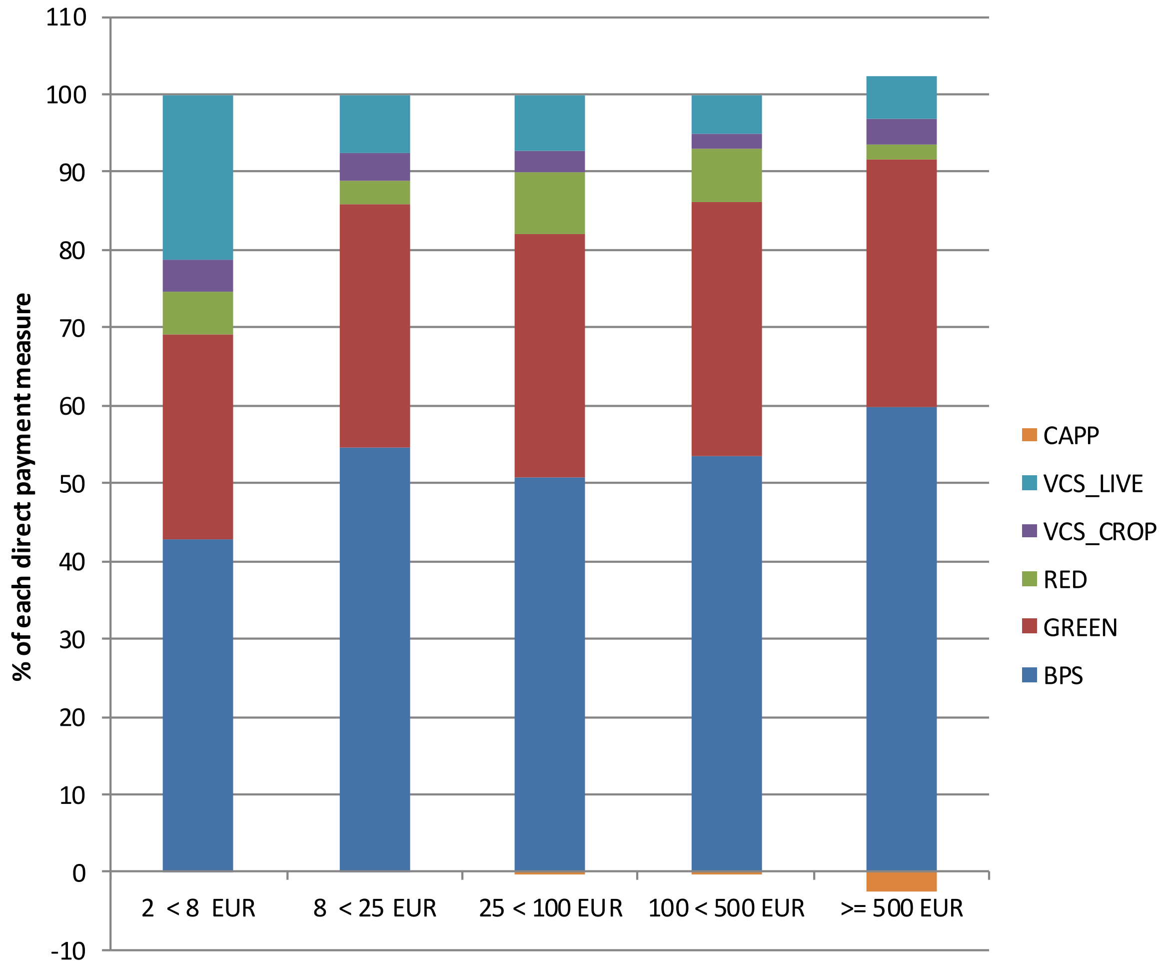
The livestock farm-types (except specialist granivores) have a higher share of voluntary coupled support (e.g. 19.7% for mixed livestock; 15.3% for specialist cattle and 15.2% for specialist milk; 12.8% for sheep and goat) compared to other farm specialisations. The strong dependency of livestock sector for the coupled support is confirmed by the higher share of voluntary coupled support associated to livestock (VCS_LIVE) compared to crop (VCS_CROPS) sectors: 7.10% of CAP direct payments are linked to livestock sector, while only 2.70% are associated to crop sector. Smaller farms tend to receive a greater share of their subsidies in form of coupled payments. This is particularly the case of farm belonging to the smallest economic size class (between EUR 2,000 and EUR 8,000 of Standard Output) for which coupled payments represent around 25% of total direct payments. As a result, the farm types with higher share of coupled payments are expected to be the most affected by the removal of direct payments in terms of changes in livestock activities and land use.

Figure 2: The structure CAP direct payments by farm specialisation in baseline in EU-27



Notes: CAPP - Capping; VCS_LIVE - livestock coupled payments, VCS_CROP - crop coupled payments, RED-redistributive payment, GREEN – greening payment, BPS - .Basic Payment Scheme/Single Area Payment Scheme.

Figure 3: The structure of CAP direct payments by farm economic size in baseline in EU-27



Notes: The economic size classes are presented in 1000 EUR of Standard Output

CAPP - Capping; VCS_LIVE - livestock coupled payments, VCS_CROP - crop coupled payments, RED-redistributive payment, GREEN – greening payment, BPS - .Basic Payment Scheme/Single Area Payment Scheme.

4.2. Land Use effects

The impact of the removal of direct payments on land-use for different farm types is shown in Tables 5 and 6 (the results for individual activities are presented in the Appendix in Figures A1 and A2). The simulations illustrates that the reduction of direct payments leads to a substantial change in area allocation among different crops for the majority of the farm specialisations in the EU-27. In general, farms experience greater changes in minor activities in which they are not specialised (e.g. cereal and animal activities for permanent crop farms; vegetables and permanent crops for field cropping farms and livestock farms; oilseeds for livestock farms) than for core activities. This effect could be explained by lower adjustment costs and lower opportunity costs for minor activities than for core activities. This indirectly implies that, when subsidies are removed (particularly coupled payments), farms adjust minor activities to a larger extent than core ones, which remain less affected.

The cereal area decreases in most of the farm specialisations (on average by -2.67%) in EU-27, except in the case of specialist sheep and goats where we observe an increase by 11.3% relative to baseline. There is a significant increase in oilseeds area (on average by 28.7%) across all farm specialisations, except for specialist olives, while the cultivation of vegetables and permanent crops increase by 4.62%. The increase in oilseeds, vegetables and permanent crop area is mainly caused by the increase in producer prices. Grassland is adversely affected by the removal of direct payments - decreasing by 4% relative to baseline (shown in Figure A1 in appendix) - driven by the reduction in livestock activities (Table 6).

The removal of direct payments leads to a reduction in cattle activities between -10% and -0.5% across farm specialisations in EU-27 which is mainly driven by the elimination of coupled payments to cattle activities and the decrease in beef prices. On the other hand, dairy cows tend to increase across most farm specialisations stimulated by higher milk producer price. On aggregate, other animal numbers are less impacted by the removal of direct payments and the figures are more mixed across farm specializations in EU-27 varying between -1.5% and 3% relative to baseline. For specific categories the impact could be more substantial. For example, the number of laying hens, which form part of the other animal category, increases by 9% relative to baseline in EU-27, while for pigs, sheep and goats there is no big differences relative to baseline (less than 1.2% in in EU-27) (Figure A2 in Appendix).

The simulated effects are less heterogeneous between economic sizes classes than between farm specialisations. However, there is a relatively consistent pattern indicating an inverse relationship between the magnitude of the simulated impacts and economic farm size. The exceptions to this are vegetables and permanent crops, where the reverse pattern is observed. The main explanation for this inverse relationship could be the greater subsidy dependence of small farms (see Table 4) and the higher proportion of coupled subsidies (see Figure 3), which leads to stronger impacts compared to large farms when direct payments are eliminated. In addition, small farms are usually involved in fewer activities than large farms, which cause greater changes in relative terms when simulating policy shocks (e.g. the average number of crops is 6.2 for farms below 100 thousand EUR, while for smaller farmers is 6).

Table 5: Crop area and animal number changes by farm specialisation under NoCAP scenario in EU-27 (% change to the baseline)

	Cereals	Oilseeds	Vegetables and Permanent crops	All cattle activities	Other animals
Specialist COP	–3.63	21.24	27.37	–5.09	2.42
Specialist other field crops	–5.99	33.09	17.00	–5.40	2.22
Specialist horticulture	–13.26	10.54	8.76	–9.34	1.30
Specialist olives	–13.01	–5.56	3.04	–7.34	1.55
Specialist wine	–6.05	18.38	–0.39	–3.86	–1.21
Specialist orchards – fruits	–6.12	38.30	–2.09	–8.80	–0.79
Permanent crops combined	–6.69	13.74	0.52	–3.56	2.95
Specialist milk	–0.98	42.16	37.36	–0.52	0.25
Specialist sheep and goats	11.03	220.30	2.53	–3.47	–0.08
Specialist cattle	4.79	30.48	6.61	–4.10	–0.87
Specialist granivores	–2.72	14.30	27.47	–2.08	0.04
Mixed crops	–6.12	32.62	3.25	–5.57	0.56
Mixed livestock	–1.69	97.80	16.39	–4.45	–1.12
Mixed crops and livestock	–1.17	27.24	11.15	–3.96	0.30

Table 6: Crop area and animal numbers changes by farm size under NoCAP scenario in EU-27 (% change to the baseline)

Farm size (in thousands EUR)	Cereals	Oilseeds	Vegetables and Permanent crops	All cattle activities	Other animals
2 - < 8 EUR	–7.48	199.46	0.89	–11.02	–5.19
8 - < 25 EUR	–0.24	55.66	2.30	–8.66	0.95
25 - < 100 EUR	–1.90	29.59	4.79	–3.14	0.98
100 < 500 EUR	–3.90	16.12	7.91	–0.67	0.48
>= 500 EUR	–1.42	8.94	7.10	0.06	0.55

Notes: The economic size classes are presented in 1000 EUR of Standard Output

4.3. Income effects

Figures 4 and 5 present income changes caused by the removal of direct payments for different farm specialisations and farm sizes in EU-27, respectively. Note that, alongside the reduction in subsidies, the income changes are driven by the prices and yields effects simulated by the CAPRI model.

Across farm specialisations in EU-27, the removal of CAP direct payments leads to farm income change varying between –28% to +5% compared to baseline. The income change variation is much smaller across the different economic size classes: from –12% to –1.4%. This is because sector-specific effects are diluted among different farm specialisations belonging to the same economic size class. These income changes are largely driven by the elimination of direct payments rather than price and yield changes induced by market feedback. The correlation ratio between the direct payments as a proportion of total income in the baseline scenario and the income change in the NoCAP scenarios for both farm specialisations and economic size classes is greater than 90%.

Subsidy-dependent farms experience a significant reduction in income (15% or more), such as specialist cattle, specialist COP and specialist olive farms. On the other hand, farms specialised in granivores, milk, other field-crops and horticulture production experience an increase in income because they are less dependent on subsidies while they benefit from the market effects (i.e. prices and yields changes). Small farms seem to experience greater income losses than large farms in the NOCAP scenario due to their higher subsidy dependency in the reference scenario.

Figure 4: Income effects of direct payments' removal by farm specialisation in EU-27 (% change compared to baseline)

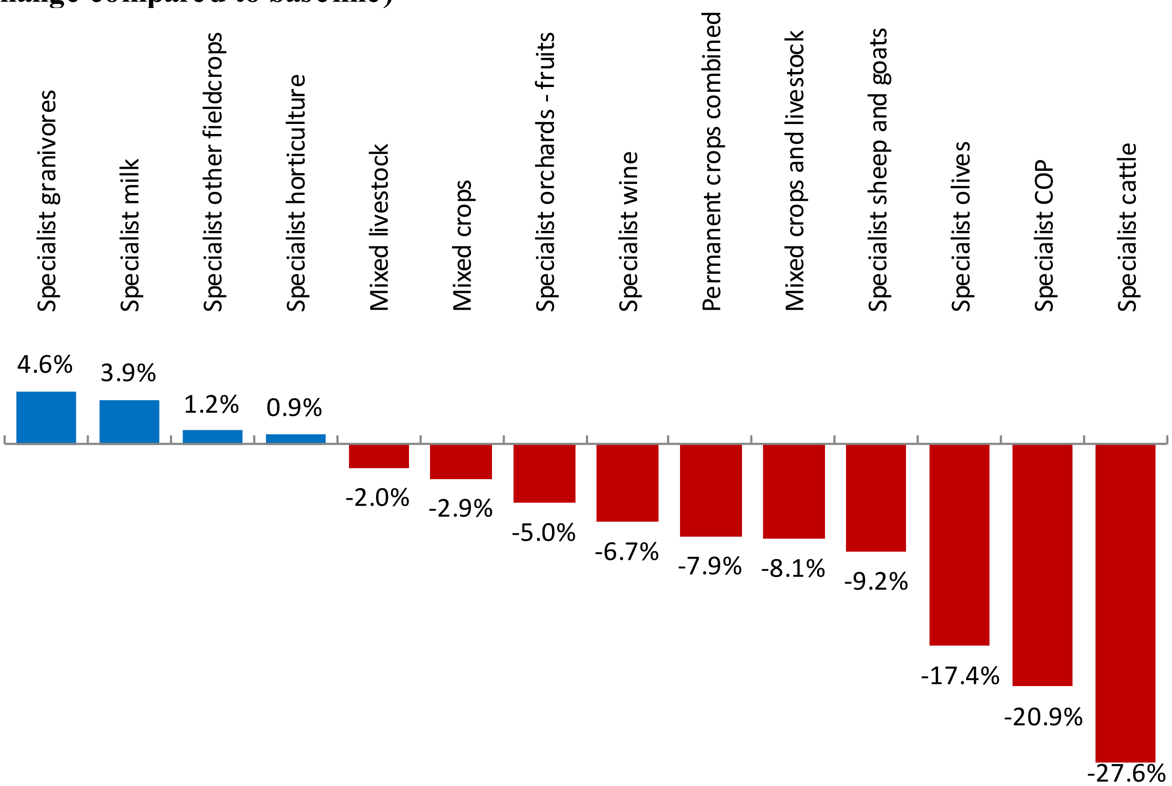
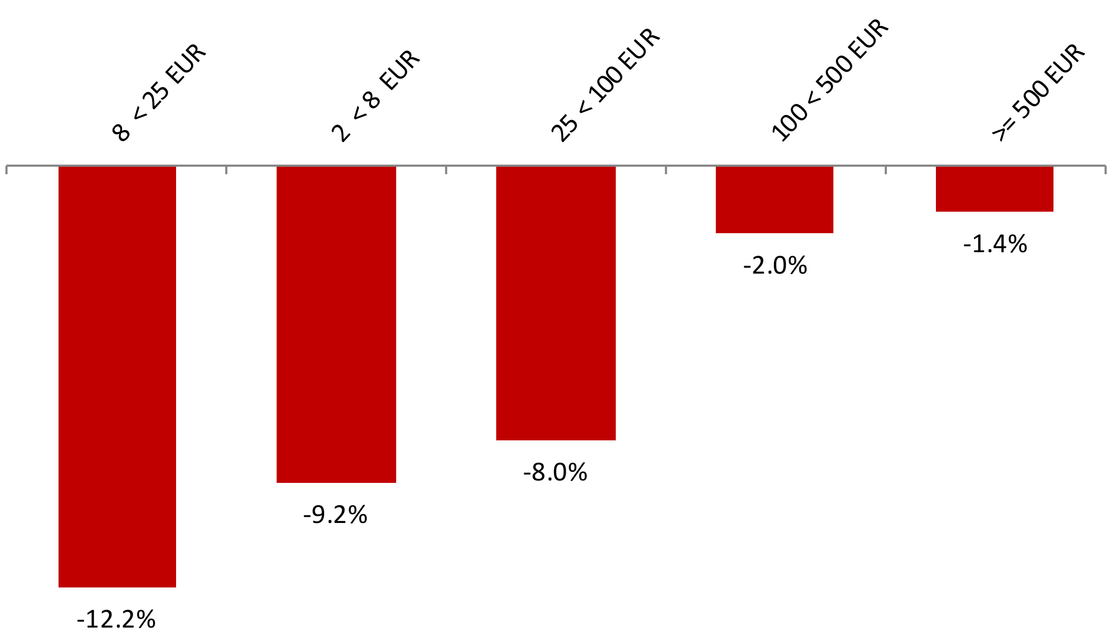


Figure 5: Income effects of direct payments' removal by farm size in EU-27 (% change compared to baseline)



Notes: The economic size classes are presented in 1000 EUR of Standard Output

The removal of direct payments leads to strong impacts across farm populations in EU-27 (Figure 6). Some farms might become vulnerable in terms of attaining sufficient income to maintain farming. Further, simulation results show that most farms (around 77% of all farms) lose income in comparison to the baseline situation. Around 11.8% of all farms lose between EUR 10/ha and EUR 100/ha and 60% lose between EUR 100/ha and EUR 1,000/ha relative to baseline. Further, Figure 7 shows that the proportion of farms with a negative income is 2.9% of the total number of farms in the baseline scenario but this proportion increases to 4.4% of farms in the NoCAP scenario. In terms of the UAA, the proportion of UAA of farms with a negative income increases from 3.4% of total UAA in the baseline to 6.2% in the NoCAP scenario. The farms with negative income include the ones whose revenue obtained from the sale of agricultural products and from direct payments (in baseline) does not fully cover variables costs such as expenses on fertilizers, pesticides, seeds, feed, etc. These farms represent the most vulnerable group because they are not even able to cover the basic production related expenses. These farms have also limited possibility to finance the renovation of capital and machinery or farm growth or to pay labour costs and thus many of them might be under pressure to exit farming. This means that there could be more farms with negative income if these costs are included in the income calculation. This implies that the farms reported in Figure 7 represent the most vulnerable farms from economic viability point of view; and thus they represent a lower bound of the number of farms that are at risk to exit farming.

Figure 6: The distribution of farm income change caused by the removal of direct payments across the farm population in EU-27 (absolute change relative to baseline)

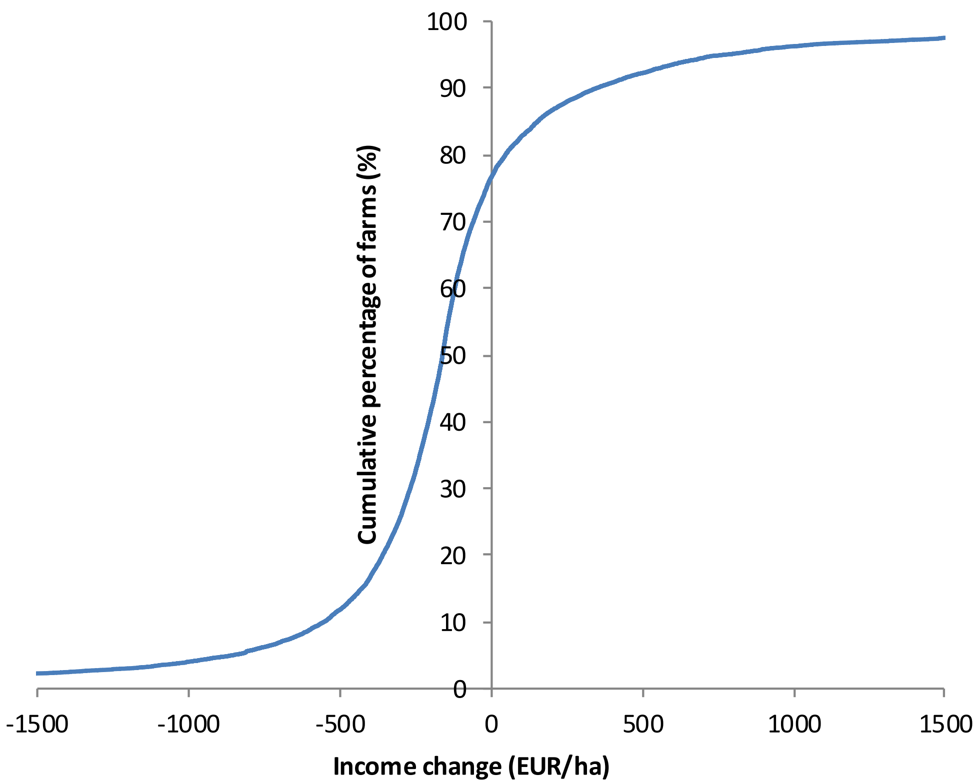
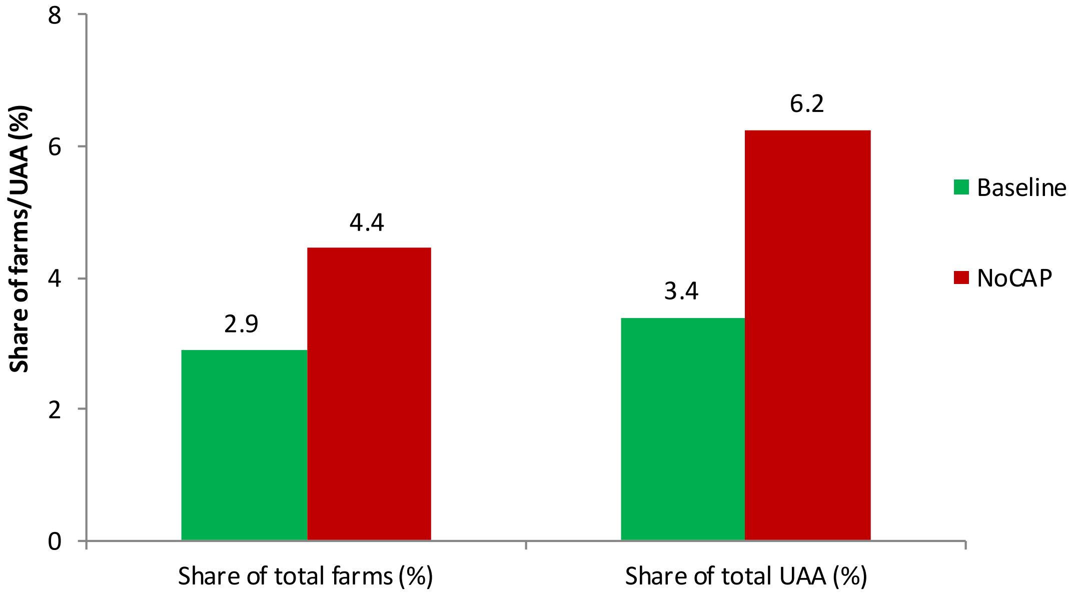


Figure 7: Farms with negative income in the EU-27 (% of all farms/UAA)



5. Discussion and conclusions

This paper presents the impact of a radical CAP reform that assumes a hypothetical scenario where coupled and decoupled payments are removed. We employ an EU-wide individual-farm-level model (IFM-CAP) to ex-ante assess the impacts of this scenario on EU farmers. The rationale for using IFM-CAP model is that it provides finer and deeper analysis of the simulated policy scenario, allows modelling farm-specific policies such as CAP direct payments (including greening) and captures farm heterogeneity across the EU in terms of policy impacts.

The simulation results show that effects of removal direct payments are relatively substantial and are very heterogeneous among farms in EU. Farms that are more dependent on CAP subsides are more affected (e.g. specialist cattle and specialist COP and smallest economic size farms), while farms with higher economic output and more labour and capital intensive production are less affected (e.g. specialist granivores). For comparison, a similar scenario was analysed in a study by Vrolijk *et al* (2010) using FADN but without using a behavioural model. In their analysis, the variable of analysis was family farm income. Compared to our indicator, they additionally considered farming-overheads, depreciation and remuneration of inputs (work, land and capital) which are not the property of the holder (wages, rent and interest paid) as well as subsidies and taxes on investment. Overall, their results are similar to ours regarding the farm-types that are most (fieldcrops and grazing livestock) and least affected (granivores and horticulture). However, in their case there are no farm-types with increase in income, while in our case there are farm-types positively affected. This is explained by the fact that IFM-CAP endogenously simulates production changes considering price/yields feedbacks derived from the market model CAPRI. Further, our analyses provide land allocation effects, which are not available in Vrolijk *et al* (2010).

The potential establishment of the radical CAP reform simulated in this paper might increase the vulnerability of some farms in terms of attaining sufficient income to maintain farming. The simulation results show that CAP direct payments play an income stabilisation role among farms in the EU. As much as 63.8 % of farms loose more than EUR 100 per hectare of income if direct payments are eliminated.

Our analysis provides insights to better design policy instruments. The simulated heterogeneous income reduction and land allocative effects in our paper suggest that the main potential effects caused by the abolition of direct payments could be alleviated with a more targeted approach. For example, the direct payments cuts could be targeted on vulnerable farms with low income levels.

One needs to be aware when drawing conclusions that our findings obviously reflect the assumptions in the model. First, in our model, we assume a fixed farm structure, implying that we do not consider farm exit and entry as a response to the policy changes. In reality, farmers may exit farming if income reduces significantly when direct payments are removed. A second potential caveat to our analysis is that we do not take into account changes in land rental prices caused by direct payments. The abolition of direct payments is expected to reduce the land rental prices and therefore having alleviating effects on farm income particularly for farms that rent a substantial share of land.

Finally, the literature suggests that when there is a decrease in a stable source of income (such as direct payments) farmers tend to choose less risky production options in order to reduce income volatility associated with variability of prices and yields (e.g. Andersson et al., 2005). These options include diversifying their production or cultivating less risky (even if may be less profitable) agricultural activities. Our simulation results do not confirm the increase of diversification in agricultural activities when direct payments are removed. In fact, the average number of crops per farm decreases from 6.08 crops in baseline to 5.25 crops in NoCAP scenario. This may be explained by the fact that the elimination of direct payments implies also removal of greening measures under which crop diversification measure requires greater diversity of crop grown on the farm. The fact that famers goes for less risky activities is not considered as the modelling of risk in IFM-CAP assumes a Constant Absolute Risk Aversion (CARA). A DARA (Decreasing Absolute Risk Aversion) model is more flexible and allows for considering that the initial wealth (depending partially on direct payments) determines the farmers' degree of aversion (Petsakos and Rozakis, 2015) and therefore affects land-allocation.

A careful analysis of each of these limitations to the current model is needed to test the robustness of these results and to provide a complete picture of the EU-wide impact of removing CAP direct payments. Overall, this paper provides insights by providing EU-wide analysis that is relevant to the policy debate on the efficacy of CAP in achieving its objectives.

References

Andersson, H., Bharat Ramaswami., B., Charles B. Moss, C., Erickson, K., Hallahan, C. and Richard Nehring. (2005). Off farm income and risky investment. What Happens to Farm and Nonfarm Assets?. Selected Paper for presentation at the 2005 AAEA annual meeting Providence, RI July 24-27.

Arribas, I., Louhichi, K., Perni, A., Vila, J. and Gomez-y-Paloma, S. (2017). Modelling Farmers' Behaviour toward Risk in a Large Scale Positive Mathematical Programming (PMP) Model. In Tsounis, N., and Vlachvei, A (eds). *Advances in Applied Economic Research – Proceedings of the 2016 International Conference on Applied Economics (ICOAE)*. Cham: Springer, 625-643.

Britz, W. and Witzke, H.P., (2014). CAPRI model documentation. Institute for Food and Resource Economics. University of Bonn. Retrieved February 8, 2016, http://www.capri-model.org/dokuwiki/..%5Cdocs%5CCAPRI_documentation.pdf.

Ciaian, P., D. Kancs and M. Espinosa (2018). "The Impact of the 2013 CAP Reform on the Decoupled Payments' Capitalisation into Land Values." *Journal of Agricultural Economics* Fortcomming.

Cortignani, R. and Dono, G. (2015). Simulation of the impact of greening measures in an agricultural area of the southern Italy. *Land Use Policy* 48: 525–533.

European Commission (2018). A new, modern Multiannual Financial Framework for a European Union that delivers efficiently on its priorities post-2020. The European Commission's contribution to the Informal Leaders' meeting on 23 February 2018 (COM(2018) 98 final).

De Frahan, B.H., Buysse, J., Polomé, P., Fernagut, B., Harmignie, O., Lauwers, L., Van Huylenboreck, G. and Van Meensel, J. (2007). Positive Mathematical Programming for Agricultural and Environmental Policy Analysis: Review and Practice. In: Weintraub, A., Romero, C., Bjørndal, T., Epstein, R., Miranda, J., eds., Handbook of Operations Research in Natural Resources. *International Series in Operations Research and Management Science* 99(1), 129-154.

European Commission (2016). "Productivity in EU agriculture - slowly but steadily growing EU." Agricultural Markets Briefs No 10, European Commission.

European Commission (2017). "Report on the distribution of direct payments to agricultural producers (financial year 2016)." Ares(2017)5942828, European Commission, <https://ec.europa.eu/agriculture/sites/agriculture/files/cap-funding/beneficiaries/direct-aid/pdf/annex2-2016_en.pdf>.

Gocht, A., W. Britz, P. Ciaian, and S. Gomez y Paloma. 2013. Farm Type Effects of an EU-wide Direct Payment Harmonisation. Journal of Agricultural Economics 64(1): 1-32.

Heckelei, T. (2002). Calibration and Estimation of Programming Models for Agricultural Supply Analysis. Habilitationsschrift an der Landwirtschaftlichen Fakultät der Rheinischen Friedrich-Wilhelms-Universtität, Bonn.

Kilian, S., Anton, J., Salhofer, K. and Roder, N. (2012). "Impacts of 2003 CAP Reform on Land Rental Prices and Capitalization." *Land Use Policy* 29(4): 789–797.

Klaiber, A.L, K. Salhofer and S.R. Thompson (2017). "Capitalisation of the SPS into Agricultural Land Rental Prices under Harmonisation of Payments." *Journal of Agricultural Economics* 68(3): 710-726.

Latruffe, L., Dupuy, A. and Y Desjeux. (2013). What would farmers' strategies be in a no-CAP situation? An illustration from two regions in France. *Journal of Rural Studies* 32: 10-25.

Louhichi, K.; Ciaian, P.; Espinosa-Goded, M.; Perni, A.; Colen, L. and S. Gomez y Paloma. (2017a). Does Crop Diversification Measure impact EU farmers' decisions? An assessment using an Individual Farm Model for CAP Analysis (IFM-CAP). *Land Use policy 66*:250-264

Louhichi, K., P. Ciaian, M. Espinosa, A. Perni and S. Gomez y Paloma (2018a). “Economic impacts of CAP greening: application of an EU-wide individual farm model for CAP analysis (IFM-CAP).” *European Review of Agricultural Economics* 45(2): 205–238.

Louhichi, K., Espinosa, M., Ciaian, P., Vosough Ahmadi, B., Perni, A., Colen, L. and S. Gomez y Paloma (2018b). The EU-Wide Individual Farm Model for Common Agricultural Policy Analysis (IFM-CAP v.1): Economic impacts of CAP greening. Joint Research Centre, EUR 28829 EN.

Matthews A. (2017), “Why Further Reform? Appendix 1.” In *CAP - Thinking out of the Box*. Brussels: Rise Foundation.

Markowitz, H. (2014). Mean–variance approximations to expected utility. *European Journal of Operational Research* 234: 346–355.

M'barek, R., , Barreiro-Hurle, J., Boulanger, P., Caivano, A., , Ciaian., Pavel, Dudu.,H., , Espinosa Goded, M., , Fellmann, T., , Ferrari, E. Gomez y Paloma, S.,Gorrin Gonzalez, C., , Himics, M., Louhichi, K., , Perni Llorente, A., , Philippidis, G., Salputra., G., Witzke., , Pe., and G. Genovese. (2017). Scenar 2030 - Pathways for the European agriculture and food sector beyond 2020, No JRC108449, JRC Working Papers, Joint Research Centre (Seville site)

Michalek, J., Ciaian, P. and Kancs, D. (2014). "Capitalization of the Single Payment Scheme into Land Value: Generalized Propensity Score Evidence from the European Union." *Land Economics* 90(2): 260-289.

O’Neill, S. and Hanrahan, K. 2016. The capitalization of coupled and decoupled CAP payments into land rental rates. *Agricultural Economics* 47: 1–10.

Paris, Q., and Howitt, R.E. (1998). An Analysis of Ill-posed Production Problems Using Maximum Entropy. *American Journal of Agricultural Economics* 80(1): 124-138.

Petsakos, T. and Rosakis, S. (2015). Calibration of agricultural risk programming models. *Journal of Operational Research* 242: 536-545.

Pratt, J.W. (1964). Risk Aversion in the Small and in the Large. *Econometrica* 32: 122-136.

Raggi, M., Sardonini. L. and D. Viaggi. (2013). The effects of the Common Agricultural Policy on exit strategies and land re-allocation. *Land Use Policy* 31: 114-125.

Solazzo, R., Donati, M., Arfini, F. and Petriccione, G. (2014). A PMP model for the impact assessment of the Common Agricultural Policy reform 2014-2020 on the Italian tomato sector. *New Medit* 2, 9-19.

Van Herck, K., Swinnen, J. and Vranken, L. (2013). "Capitalization of Direct Payments in Land Rents: Evidence from New EU Member States." *Eurasian Geography and Economics* 54(4): 423–443.

Van Zeijts, H., Overmars, K., van der Bilt, W., Schulp, N., Notenboom, J., Westhoek, H., Helming, J., Terluin, I. and Janssen, S. (2011). Greening the Common Agricultural Policy: impacts on farmland biodiversity on an EU scale (Policy Report No. 500136005). PBL Netherlands Environmental Assessment Agency, The Hague.

Vosough-Ahmadi, B., Shrestha, S., Thomson, S.G., Barnes, A.P., and Stott, A.W. (2015). Impacts of greening measures and flat rate regional payments of the Common Agricultural Policy on Scottish beef and sheep farms. *Journal of Agricultural Science*, 153: 676-688.

Vrolijk, H., De Bont, C., Blokland, P., Soboh, R. (2010). Farm viability in the European Union: assessment of the impact of changes in farm payments. LEI report 2010-011.

Appendix

Figure A1: Impact on crop area by sector in the NoCAP scenario in EU-27 (% change to the baseline)

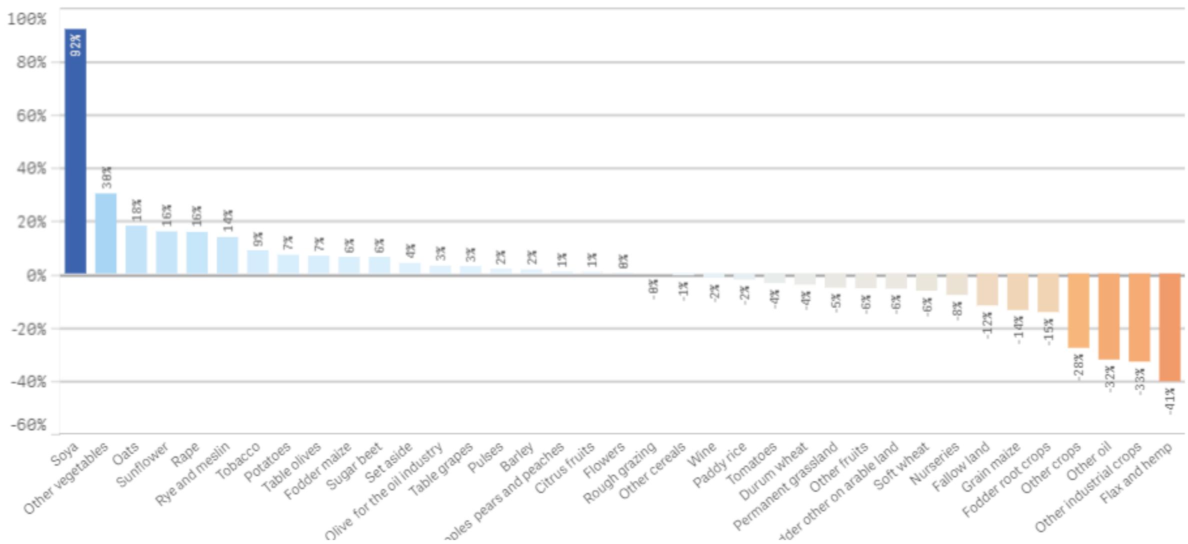


Figure A2: Impact on animal numbers in the NoCAP scenario in EU-27 (% change to the baseline)