EU-wide impacts of the 2013 CAP direct payments reform: A farm-level analysis

This paper analyses the microeconomic effects of the 2013 reform of the EU's Common Agricultural Policy (CAP). This is done using the EU-wide individual farm model (IFM-CAP). Simulation results show that although the reform succeeded to partially harmonize DPs among farms and MS, relatively strong differences in the distribution still remain in place. Around 62% of the farms increase their income, whereas the remaining 38% lose from the reform. The reform benefits small farms, while large farms lose out. As measured by the Gini coefficient, the 2013-CAP reform only partially reduces the disparity in the distribution of DPs and farm income among farms. The Gini decomposition shows that subsidies (in particular decoupled payments) contribute to a decrease in the inequality of total farm income. The future CAP reform needs to have a stronger overhaul of the DP system in order to achieve a substantial reduction in inequality in the distribution of payments among farms and regions in EU.

1. Introduction

The EU's Common Agricultural Policy (CAP) provides financial support to farmers and rural areas. The CAP is based on a two-pillar structure. Pillar I support includes direct payments (DPs) to farmers (73% of total CAP budget) and market intervention measures. Pillar II support focuses on improving the structure and environmental benefits of agriculture, and on promoting rural development. In this paper, we will focus on the economic impacts of DPs granted under Pillar I support.

Over the last two decades, Pillar I has undergone a gradual change from market intervention instruments (e.g. price support) to decoupled support, aimed at reducing interference in farmers' production decisions. The main drivers of the introduction of decoupled direct payments (DDP) were budgetary constraints implied by the EU enlargement towards the Central and Eastern European countries in 2004 and 2007, and the World Trade Organization pressures to reduce trade distortions caused by the CAP (Swinbank, 2008; Swinnen, 2008; Erjavec and Lovec, 2017).

After the 'partial' decoupling of agricultural support through the 1992 MacSharry and Agenda 2000 reforms, the 2003-CAP reform introduced 'full' decoupling by distributing the bulk of DPs through two types of DDPs: the Single Payment Scheme (SPS) and the Single Area Payment Scheme (SAPS).[1] The key difference between SPS and SAPS is the area that is eligible for the payment.[2] Under the SPS, each farm was allocated a fixed amount of SPS entitlements. In order to receive the payment, farms need to activate those entitlements by declaring an equivalent number of eligible hectares on an annual basis. Under the SAPS, the entire eligible area can receive a payment per hectare (there are no entitlements).[3] When implementing the SPS, Member States (MS) were able to choose between three different SPS implementation models: the historical model , the regional (flat-rate) model , and the hybrid model . Under the historical model, the SPS is farm-specific and equals the support the farm has received in the 'reference' period, i.e. the period when partially-coupled direct payments were given to farmers. Under the regional model, a uniform hectare payment is granted to all farms in a given region. The hybrid model is a combination of the historical and regional models (Kilian and Salhofer 2008; Ciaian et al., 2014).[4]

The 2013-CAP reform largely preserved the pre-reform structure of Pillar I direct payments, but with some modifications related to the level of payments and their conditionality. The main changes introduced include: (i) the harmonization of DDPs across farms and regions in the EU, (ii) the introduction of the so-called CAP greening measures and (iii) the rebalancing of support (about 10% of total DPs) towards the livestock sector. The reform was implemented in January 2015 as part of the 2014-2020 Multiannual Financial Framework, which establishes the allocation of funding from the EU budget to EU policies (EU, 2013; EC 2013, 2016a, 2017a).

One of the main policy objectives of the reformed system of decoupled payments was to partially eliminate the disparities in the level of DPs received by farms within and between MS (i.e. internal and external convergence) (EC, 2011, 2013). Prior to the reform, farmers in OMS received higher payments than farmers in NMS. In addition, farmers that had historically high coupled direct payments (prior to the

2003-CAP reform) received higher DDPs per hectare than other farmers in MS that implemented the historical and hybrid SPS models. In order to reduce the disparities in DPs between farms, the 2013-CAP reform provides a menu of options for implementing the new system of DPs. MS could choose the reform strategy and the degree of harmonization (full versus partial harmonization) of the per hectare DDPs. Furthermore, in order to generate a more 'equitable' distribution of DPs, MS could implement additional direct payment measures such as redistributive payments, coupled support, small farmer schemes and payments for areas facing natural constraints (ANC) (EC, 2011; EU, 2013).

Another key objective of the 2013 reform was the 'greening' of the CAP. The aim of the greening was to enhance the environmental performance of the farming sector by incentivizing the provisioning of environmental public goods for the benefit of society in return for receiving DPs (EU, 2013).

Given that the 2013-CAP reform has introduced changes to the support system, an important policy question is whether this reform has led to a more equal distribution or equality of total direct payments among European farms and to what extent it has had an impact on agricultural production and income distribution among farms (i.e. who are the losers and who are the winners of the reform) [5]. Answering these questions provides evidence as to whether the CAP reform has achieved its objectives of providing a more equal distribution of DPs among farms and regions.

Following this policy background, the main objective of this paper is to quantify the impacts of the new DP system (including the greening of the CAP) on income and production as well as distributional effects across EU farms. This is done using the EU-wide microeconomic farm model IFM-CAP (Individual Farm Model for Common Agricultural Policy Analysis), which takes into account farms' behavioural responses to the simulated policy changes. The key advantage of IFM-CAP relative to other modelling approaches is that it models individual farms in the EU, which allows the farm-specific implementation and the impacts of the changes in DPs to be captured (Louhichi et al. 2013, 2017, 2018). This paper provides a comprehensive analysis of the EU-wide impacts of the 2013-CAP reform at the farm level.[6]

Note that, in this paper, we focus on the economic impacts of the 2013-CAP reform. The environmental effects of the reform are not analysed here (for the environmental impacts, see Gocht et al. 2017).

The paper is structured as follows. The next section provides an overview of the 2013-CAP reform, which is followed by the section presenting the IFM-CAP model. The fourth section presents the scenarios simulated in the paper. The fifth section explains the simulated results. The final section draws the main conclusions and policy implications.

2. The 2013-CAP Reform

The 2013-CAP reform introduced various changes that modify the value of DPs (i.e. coupled and decoupled payments) and the way in which they are allocated across farms. The first important change was the reduction in the overall CAP budget (3.5% in real terms considering 2011 prices) for the post-reform period 2014-2020 compared to the pre-reform period 2007-2013 (Anania et al., 2015). The main reason for this reduction is that the post-reform CAP budget was frozen at its pre-reform nominal value which meant a decrease in real terms over time (EC 2013; Matthews 2014).

The second key element of the 2013-CAP reform affecting DPs is the possibility of MS to transfer funds between Pillar I (DPs) and Pillar II (Rural Development Payments). MS can shift up to 15% of their annual ceiling for DPs to Pillar II or *vice versa*. MS with an average DPs per hectare below 90% of the EU average are allowed to transfer up to 25% of the RDP to DPs. In the year 2019, 10 MS decided to shift funds from Pillar I to Pillar II (between 1.3% and 15% of their CAP budget), while five MS did the reverse (between 3.8% and 25% of their CAP budget) (EC, 2016c).

An additional element of the 2013-CAP reform that changes the allocation of DPs between MS is the external convergence of DPs. The external convergence partially harmonizes the payments among MS by adjusting them either upwards or downwards to bring them closer to the EU average. More specifically, the national budgets of MS where the average payment (in EUR per hectare) is below 90% of the EU average will be gradually increased (by one third of the difference between their current rate and 90% of

the EU average). This convergence is proportionally financed by MS that have payment levels above the EU average level (EU, 2013). Due to the external convergence, most NMS (with the exception of Cyprus, Malta and Slovenia) have observed an increase in their DPs, while most OMS (with the exception of Spain and Portugal) have registered a reduction in DPs (Anania et al., 2015). Other main elements introduced by the 2013-CAP reform can be summarized as follows (EU, 2013; EC 2015, 2016a):

1. *Internal convergence of decoupled payments:* the 2013-CAP reform aims to eliminate or reduce the heterogeneity of the per hectare Basic Payment Scheme (BPS)[7] in a given region or MS. MS apply either (i) full convergence (i.e. introduction of a flat-rate) or (ii) partial convergence. Under full convergence, an equal per hectare payment is granted to all farms in a given region or MS. All MS that previously implemented the SAPS continue with it, which is a flat-rate area payment scheme.
2. *Redistributive payment:* this payment aims to increase support to small and medium-sized farms by granting a higher payment for the first hectares than for the remaining farm area.
3. *Degressivity/Capping payments:* degressivity and capping of BPS/SAPS payments aim to reduce total payments for the largest farms. Similar to redistributive payments, capping aims to generate a more equal distribution of DPs between farms. Degressivity means that MS are required to reduce BPS/SAPS payments, by at least 5% for payments above €150,000 per farm (with the possibility to deduct salaries from the payments before applying the reduction).
4. *Entitlement allocation*: MSs that previously implemented SPS have either (i) maintained pre-reform entitlements or (ii) allocated new entitlements based on the eligible area in the first year of the reform implementation (i.e. in 2015) to farms which were eligible for DPs in 2013.
5. Introduction of new measures such as the *young farmer scheme*, *small farmer scheme* and *payments for ANC* with the aim to target specific farmers and areas facing difficult conditions.
6. *CAP greening*: the reformed CAP intends a stronger linkage of the direct payments to agricultural practices beneficial to the climate and environment through three greening measures: crop

diversification, maintenance of permanent grasslands and ecological focus areas (EFA). CAP greening is linked to 30% of the total direct payments.

7. *Coupled direct payments:* CDPs are linked to a specific production activity and take the form of a payment granted per hectare of a particular crop or head of particular livestock. MS can grant CDPs for the purpose to maintain the current production level in regions or sectors that face certain difficulties and are perceived important for economic, social or environmental reasons. MS can allocate up to 13% of the national ceilings to CDPs. In 2015, around 10% of the DP budget was allocated to CDPs varying between 0% (in Germany) to 57% (in Malta)[8]. The highest share of CDPs in EU was granted to beef and veal sectors (40% of total CDPs) followed by milk and dairy sectors (19%), sheep and goat sectors (11%) and protein crops (9%) (EC, 2017a).

3. The IFM-CAP model

In order to analyse the impact of the direct payments reform, we use the IFM-CAP model. IFM-CAP is a farm-level model designed for the economic and environmental analysis of EU agriculture. The IFM-CAP model is a static positive mathematical programming model which solves a set of microeconomic models reproducing the behaviour of individual farms. The model assumes that farmers maximise their expected utility at given yields, product prices and production subsidies, subject to resource (arable land, grassland and feed) endowments and policy constraints such as the CAP greening restrictions (Louhichi et al. 2018; see also Appendix).

The main advantage of the IFM-CAP is that it models a large sample of individual farms in the EU, which allows capturing farm heterogeneity to a degree which is sufficient to capture the impacts of the new DPs as introduced by the 2013-CAP reform. The micro-level detail of IFM-CAP is important because both the pre-reform and post-reform DPs are farm-specific. The direct payments that each farm receives after the reform are dependent on the implemented model in the pre-reform period (e.g., historical SPS model, hybrid SPS model, SAPS, regional SPS model) and the implemented scheme in the post-reform

144 period (e.g., partial convergence versus full convergence). Further, the CAP greening practices target land
145 allocation at the farm level implying that their adoption and impacts largely depend on farm-specific
146 characteristics (size, specialisation, location, etc.).

147 The advantage of IFM-CAP compared to other models used for CAP impact analysis is that it combines
148 EU-wide geographical coverage and the use of individual farm data that allows simulation of policy
149 impacts across all EU farming systems and regions (Britz and Witzke, 2014; Louhichi et al. 2017, 2018).
150 Further, the advantage of IFM-CAP compared to statistical approaches is that the latter require EU-wide
151 farm level data with a full implementation of the 2013-CAP reform which, however, are not available. In
152 fact, the full implementation of the 2013-CAP reform (e.g. decoupled payment convergence) will only
153 enter into force in several MS in 2019.

154 However, IFM-CAP has some limitations that need to be accounted for when analysing the simulation
155 results. These limitations refer to the fact that (i) IFM-CAP does not consider farm structural change (i.e.
156 total farm area is assumed to be constant; there is no interaction between farms, neither farm exit/entry
157 nor substitution between arable and grassland) (ii) the impact of DPs on farm-rental values is not
158 considered because IFM-CAP does not model land markets and (iii) a soft link with CAPRI model[9] is applied
159 in order to account for output price and yield effects in the IFM-CAP under both the Baseline and policy
160 scenarios (i.e., no price-supply interaction is modelled between farm level behaviour in IFM-CAP and the
161 market level response in CAPRI) and (iv) IFM-CAP price and yield effects are determined by the accuracy
162 of the CAPRI model simulations and consistency in CAP assumptions between the two models.

163 IFM-CAP is calibrated for the base year 2012 using cross-sectional analysis (i.e. multiple observations)
164 and the Highest Posterior Density (HPD) approach using prior information relating to NUTS2[10] supply
165 elasticities and dual values of resources (e.g. land rental prices). The calibration to the exogenous supply
166 elasticities is performed in a non-myopic way, i.e., we consider the effects of changing dual values on the
167 simulation response (for more details see Louhichi et al. 2018).

168 The primary data source used to parameterize IFM-CAP are individual farm-level data (83,292 farms
169 observations for the base-year 2012) from the Farm Accountancy Data Network (FADN) database
170 complemented by other external EU-wide data sources such as the European Farm Structure Survey (FSS),
171 the CAPRI model database (Britz and Witzke, 2014) and Eurostat (for more details see Louhichi et al. 2018).
172 The FADN is a European system of sample surveys that takes place each year and collects structural and
173 accountancy data on EU farms. In 2012, FADN represented a population of almost 4.9 million farms,
174 covering approximately 90% of total agricultural production and the area of the EU. Farm level data are
175 confidential and, for the purposes of this paper, accessed under a special agreement. The FADN survey
176 does not cover all farms in the EU, but only those that are considered to be commercial farms. FADN is
177 constructed to be representative of the number of commercial farms in each cluster (defined by region,
178 economic size and production specialization) and therefore it might not be representative for the area of
179 each crop. As a result, the DPs may be under-represented or over-represented in the Baseline and reform
180 scenarios due to under or over-representation of certain production activities. Consequently, the analysis
181 conducted in this paper is valid for the population represented by the FADN sample.

182 **4. Scenarios: description and implementation**

183 We simulate two scenarios: a Baseline (reference) scenario and the 2013-CAP reform scenario (also
184 referred to as the 'reform scenario'). The Baselineis used for the counterfactual comparison of the reform
185 scenario in 2025.

186 *4.1. Baseline*

187 The Baseline represents the pre-reform DPs considering the future development of the farming
188 sector. Four main assumptions are adopted in order to construct the IFM-CAP Baseline: (i) a continuation
189 of the pre-reform DPs up to 2025; (ii) an exogenous adjustment of Baseline output prices and yields using
190 their changes from the CAPRI Baseline between 2025 and base year (2012); (iii) an adjustment of input
191 costs to account for improvement in farm efficiency approximated by total factor productivity (EC 2016b);

192 and (iv) an assumed inflation rate of 1.9% per year for input costs (as in the CAPRI model Baseline). All
193 other model parameters (e.g. farm resource endowments) are assumed to remain unchanged up to 2025.
194 The pre-reform DPs up to 2025 are constructed based on FADN data for the year 2012. For the DDPs
195 the use of individual farm level data is important in order to capture the farm level heterogeneity of the
196 payments as determined by the implemented scheme in a given MS (Table 1). This is particularly
197 important for MS that implemented historical or static hybrid SPS models in the pre-reform period, where
198 the hectare value of DDPs varies between farms within a region or MS. Further, under the SPS model
199 farmers are allocated entitlements that give the right to receive payments if each entitlement is
200 accompanied by one hectare of eligible land. The number of entitlements at farm level used in IFM-CAP
201 for the pre-reform period is available from the FADN.
202 For CDPs, we consider the average payment per crop/livestock unit in each NUTS2 region based on
203 the 2012 FADN data. This assumption is applied to be able to generate the value of CDP for alternative
204 activities when they are not observed in the base year. This approach of deriving the CDP ensures a more
205 homogenous treatment of observed and alternative activities in the simulation model.
206 The exogenous adjustment of output prices and yields in the IFM-CAP Baseline is implemented in
207 order to include the dynamics of market developments. The output prices and yield changes rely on the
208 CAPRI projections for 2025. The CAPRI projections are also based on the implementation of the pre-reform
209 CAP.[11] Given that the CAPRI yield and output price changes are defined at the NUTS2 level, we impose the
210 same rates on all farms belonging to the same NUTS2 region. Note that the Baseline price changes
211 represent their projections in nominal terms over the considered time horizon.
212 The total factor productivity adjustment of input costs in the Baseline attempts to capture technical
213 change and input intensification effects, while the inflation rate applied for input costs represents their
214 projections in nominal terms.

Input costs, output prices and DPs are represented in nominal terms in the Baseline. This implies that the latter decreases in real terms over the considered time horizon (i.e. in 2025 compared to the pre-reform period) because its value was frozen at its pre-reform nominal value.

4.2. Reform scenario

The reform scenario assumes the implementation of new DPs and the greening measures as established by the 2013-CAP reform. We consider DPs as planned to be implemented by MS in 2019, the year of the full implementation of the 2013-CAP reform. The 2019 DPs are assumed as unchanged up to 2025, which is the time horizon for both scenarios. Exogenous adjustments in prices and yields are applied in the reform scenario based on the CAPRI model simulations of the 2013-CAP reform (EC 2016d; Gocht et al; 2017).

We model all the main components of DDPs: BPS (or SAPS in NMS), greening payment, redistributive payments, capping and ANC payments in Pillar 1, except for the young farmer and the small farm schemes. This is because there are no available data in FADN to accurately assess the former scheme, while the latter scheme is a voluntary measure which cannot be straightforwardly modelled in the current version of IFM-CAP model. However, these two schemes only represent a minor share of the total DP budget.

To obtain farm-specific BPS payments, the 2012 FADN base year data are adjusted by considering their planned implementation in each MS in 2019, as summarized in Table 1 (EC 2015, 2016a). Similar to the pre-reform period (Baseline), in MS implementing BPS, farmers are allocated entitlements. In order to obtain the post-reform BPS values at the farm level in MSs applying partial convergence, we adjust the initial farm level BPS payments in the pre-reform period (base year obtained from FADN) using the internal convergence mechanism implemented in each MS in 2019. This approach allows us to capture the farm level heterogeneity of the unit value (per entitlement) of the BPS payment. In MS applying full convergence, an equal unit value of BPS is granted to each farm in a given region or MS, depending on whether the regional or national system is implemented. We use the FADN data to calculate the number

of entitlements at the farm level following the MS specific implementation of the 2013-CAP reform. Table 1 shows the MS specific rules concerning the maintenance of the old-entitlements or the allocation of new ones, the minimum threshold eligibility to receive DDPs (entitlements) and other MS specific considerations. That is, the post-reform number of entitlements for each farm in MS which allocated new entitlements was calculated as the total eligible area declared by farmers in the pre-reform period and the addition of new areas made eligible by the 2013-CAP reform (EC 2015, 2016a).[12] Finally, in MS that implement SAPS there are no entitlements and all eligible area receives the DDP. The SAPS payment per hectare is equal across all farms and it is calculated by dividing the SAPS ceiling by the MS's eligible hectares.

Member States can grant the greening payment either as a national/regional flat-rate per hectare or as a percentage of the BPS, implying that the per hectare greening payment varies across farms in MS implementing partial convergence. The greening payment represents 30% of the total direct payments. The redistributive payments are set in the reform scenario as applied by MS in 2019 and are shown in Table 1. The per hectare values of ANC payments are set as implemented in 2019 and only used for Denmark. The capping rules provided in Table 1 were applied to the total value of BPS/SAPS payments (EC 2015, 2016a). Following the EU regulation, we assume full compliance of the three greening measures without allowing farmers to trade-off between income reductions with full compliance versus DP reduction as a consequence of a partial or full non-compliance. We also consider MS implementation of the greening measures. A more detailed description of the greening measures and how they are modelled in the IFM-CAP are described in Louhichi *et al.* (2018).

Similar to DDPs, CDPs were modelled in the reform scenario considering their planned implementation in each MS in 2019. MS specific eligibility criteria were used to define which crops and animal categories are permitted to receive CDPs (EC, 2016c).

5. Results

5.1 Distribution of DPs

Figure 1 presents the average direct payment per hectare by MS under both the Baseline and the reform scenarios as simulated by IFM-CAP. The average per hectare DPs in EU-27 decrease by 4% between Baseline and the reform scenario: from 261 Euro/ha to 250 Euro/ha. At MS level, the change in the per hectare DPs varies between 78% in Latvia and -60% in Finland[13]. The average DP per hectare decreases by 10% in OMS and increases by 23% in NMS. Fifteen MS (mostly from OMS) register a reduction in DPs, while twelve MS (mostly from NMS) experience an increase in DPs. The 2013-CAP reform is shown to increase DPs in most MS with per hectare DPs below the EU average, whereas in most MS with per hectare DPs above the EU average, they decrease. These results are in line with one of the main goals of the 2013-CAP reform, which is to have a more equal distribution of DPs among MS (i.e. external convergence). However, as shown in Figure 1, the 2013-CAP reform did not fully eliminate the disparities in DPs among MS. Still a strong difference in DPs between MS remains after the reform; average DPs range from around 137 Euro/ha in Estonia to 595 Euro/ha in Greece.

To assess the internal convergence of DDPs across farms within a region or a MS, Figure 2 shows the distribution of the DDPs per-entitlement (or hectare)[14] across farms and by MS under the Baseline and reform scenarios. The figure includes all categories of DDPs: BPS/SAPS, greening payments, redistributive payments, ANC payments and capping.. Second, the hectare value of DDPs should be homogenous in the Baseline in MS applying SAPS. However, there are some variations observed as reported in Figure 2 (Baseline) (especially in Cyprus and Latvia) likely due to the farmers' imprecise reporting when completing the FADN survey.

As expected, Figure 2 shows that the implementation of the 2013-CAP reform leads towards a more uniform unit value of DDPs in almost all MS. The strongest effect is observed in those OMS where DDPs in the pre-reform period were highly heterogeneous among farms due to the application of historical and static hybrid SPS models. MS that introduce full convergence of DDPs (flat rate) experience the largest

convergence of DDPs (e.g. the Netherlands). The exceptions are Finland, United Kingdom and Germany, where the flat rate is differentiated by regions. In addition, Germany applies the redistributive payment, which introduces payment heterogeneity between small and large farms. In MS applying partial convergence, there is heterogeneity in the DDPs in the reform scenario; however, it is still less pronounced than under the pre-reform CAP (Baseline). Further, the figure shows that the number of farms with low-value DDPs declines substantially because the 2013-CAP reform sets a lower threshold for the lowest value payments, which should be not less than 60% of the MS average (or regional average depending on the implementation). This has an effect on the distribution of DDPs in the lower whisker of Figure 2 (2013-CAP reform) as it cuts the lower segment of the distribution in the reform scenario in most MS implementing historical and static hybrid SPS models in the pre-reform period.

In NMS the impact of the 2013-CAP reform on DDP harmonization is smaller because most of them had homogenous payments (i.e. SAPS) prior to the reform. In fact, in some NMS decoupled payments become slightly more heterogeneous. Bulgaria, Romania and Lithuania apply the redistributive payment in the post-reform period which creates some heterogeneity in DDPs among farms (i.e. between small and large farms) in the reform scenario (Figure 2).

In order to assess the distribution of the post-reform DPs (including both CDP and DDP) between farms, we calculate Gini coefficients for the Baseline and reform scenarios. DPs are relatively unequally distributed among the farms in EU-27 in Baseline indicated by a relatively high Gini coefficient of 0.63. Around 80% of farms receive 21% of DPs in Baseline. The 2013-CAP reform only partially reduces this disparity in DP distribution between farms. The Gini coefficient decreases by 0.03 points in the reform scenario (to 0.60) compared to Baseline.

Using the Gini decomposition approach proposed by Lerman and Yitzhaki (1985), the results show that BPS/SAPS and greening payments contribute to an increase in the inequality of the post-reform DPs, whereas coupled payments and redistributive payments have an equalizing effect on the distribution of

311 the post-reform DPs (not shown in a table).[15] ANC payments also reduce the inequality of the post-reform
312 DPs but their impact at EU level is negligible because they are implemented only in Denmark. These results
313 are expected, given that the allocation of BPS/SAPS and greening payments is based on the total farm
314 area and thus farms with greater area receive more DDPs than farms with a smaller area. The
315 redistributive payments does the opposite by shifting DDPs from large farms to small farms, whereas CDPs
316 allocate payments mainly to livestock farms which have smaller land endowment than crop farms[16] and
317 thus on average receive less BPS/SAPS payments.

318 *5.2 Production effects*

319 The production effects are driven by changes in coupled payments and by the introduction of CAP
320 greening. The DDPs are delinked from farm production decisions in the IFM-CAP model and hence the
321 changes made by the 2013-CAP reform to this type of payments is assumed not to affect production.

322 Given that DDPs represent the major part of support in both the pre- and post-reform periods, the
323 production effect of the 2013-CAP reform are relatively limited according to the model simulations. At the
324 EU-27 level, aggregate production decreases by 1.2% in the reform scenario compared to Baseline. The
325 production change varies between -3.7% and 2.3% across different MS. At the sectorial level, the reform
326 decreases the production of oilseeds (-1%), vegetables and permanent crops (-2.1%), cereals (-3.2%) and
327 other arable field crops (-6.5%), whereas it increases animal production (+0.7% meat; +0.4% other animal
328 products) and fodder crop activities (+1.3%). The production effects of the 2013-CAP reform tend to vary
329 more by farm specialization and economic farm size but for most farm types the production change is in
330 the interval between ±5%.[17]

331 *5.3 Income effects[18]*

332 The simulated production effects are small, however the changes introduced to DPs (particularly to
333 DDPs) by the 2013-CAP reform have greater implications for European farmers' income. At EU-27 level,
334 the results show that compared to Baseline the 2013-CAP reform will lead to a decrease in income by

around 1.3% mainly driven by the change in DDPs.[19] These income effects are, nevertheless, quite heterogeneous across MS. Consistent with subsidy changes, most NMS gain from the 2013-CAP reform driven by the external convergence of DPs between MS. The largest income gain is observed in Romania (14.6%), and the largest reduction in Finland (-7.8%) and Portugal (-7.9%). The key driver of the income changes are changes in DPs between the reform and Baseline (Table 2). This change is comparable in magnitude with the variation in income for most MS (correlation coefficient 0.84).

The most negatively affected farms by the 2013-CAP reform in EU-27 are *specialists in other field crops* (-6.7% compared to Baseline) and *specialists in olives* (-3.6%), while farms specialized in *mixed livestock* (1.3%) and *specialist sheep and goats* (+2.3) experienced increases in their income (Table 3, panel a). In general, small economic-size farms benefit, while large farms lose from the 2013-CAP reform. Income among small farms (less than 15 thousand Euros of agricultural output) increases between 1.9% and 18.4%, while large farms (over 500 thousand Euros of agricultural output) experience an income drop between 1.5% and 5%. Medium sized farms (between 15 and 500 thousand Euros of agricultural output) are less affected by the reform with their income change varying between -2.5% and 0.3% (Table 3, panel b). Approximately 62% of all farms experience an increase in income per hectare, whereas the remainder (around 38%) lose income due to the reform. These results are consistent with the fact that the number of small farms is greater than large farms and the income effects reported in Table 3 (panel b) which show that small farms tend to gain from the reform while large farms lose. The majority of farms (60%) have an income change in the interval of ±100 Euros per hectare.

As reported in Table 4, the Gini coefficient for total farm income distribution is 0.754 in the Baseline in the EU-27, decreasing slightly to 0.751 under the reform scenario (i.e. the effect on inequality is negligible). The Gini decomposition shows that both coupled and decoupled payments have an equalizing effect on the distribution of total farm income (negative marginal change in Gini), whereas market income obtained from sale of production contributes to an increase of total farm income inequality in the Baseline

and reform scenarios. According to Table 4, a 1% increase in market income, other things held constant, increases the Gini coefficient of total farm income by 5.5% and 5.9% in the Baseline and the reform scenario, respectively. This is also confirmed by high Gini correlation between market income and total farm income (0.99) in both scenarios, indicating that the market income is unequally distributed and its magnitude is skewed disproportionately towards farms at the top of the income distribution. This effect is more important for market income than for any other income sources (i.e. subsidies) as indicated by the Gini correlations. In the case of subsidies, DDPs have the strongest reduction effect on the Gini as indicated by the negative marginal change in Gini. Among the different components of DDPs implemented in the post-reform period, the largest equalizing effect on the total farm income is BPS/SAPS followed by greening payments. As shown in the share of total farm income column, the contribution of the redistributive payment and the ANC payment to the reduction of the total farm income inequality is rather small because they are implemented only in few MS (e.g. ANC payments are implemented only in Denmark).[20]

6. Conclusions

This paper evaluates the impact of the 2013-CAP reform on EU farming sector with a focus on income, production and distributional effects using the IFM-CAP model. The main finding of our paper is that the 2013-CAP reform reduces disparities in DPs among farms and MS respectively. The average hectare value of the post-reform DPs increases by 23% in NMS and decreases by 10% in OMS relative to its pre-reform level. As expected, the 2013-CAP reform internal convergence leads to a more uniform distribution of the DPs per hectare between farms in the majority of MS. The strongest DP equalization effect is observed in OMS where DDPs were most heterogeneous across farms in the pre-reform period due to the application of SPS. In NMS the impact of the 2013-CAP reform on DDP harmonization is smaller because they had homogenous payments (i.e. SAPS) in the pre-reform period. Despite the elimination of some disparities of DPs, still the 2013-CAP reform preserves a significant disparity of DPs among MS varying between

around 137 Euro/ha in Estonia to 595 Euro/ha in Greece. At the farm level, the elimination of DP inequality is also limited (the Gini coefficient decreases from 0.63 in the pre-reform period to 0.60 in the 2013-CAP reform).

The simulated impact of the 2013-CAP reform on overall farm income and production is rather limited (they decrease by 1.3% and 1.2%, respectively), which might be understated by the IFM-CAP model assumption of no production effects derived from DDPs. The income change at MS level varies between -8% and 15%. At the individual farm level, the income effects are more pronounced. Overall, around 62% of farms gain, whereas the remaining 38% of farms lose from the reform in EU-27. The simulation results suggest that small farms benefit, while large farms lose from the 2013-CAP reform. Similar to DPs, the 2013-CAP reform has minimal impact in affecting farm income inequality. Subsidies, in particular DDPs, have an equalizing effect on the distribution of income between farms, while market income contributes to farm income inequality.

Our results suggest that the future CAP reform would need a stronger overhaul of the support system if its objective is to achieve a more equal distribution of payments between farms and regions in EU. Despite the fact that small farms are clear winners from the 2013-CAP reform, additional measures still need to be adopted to address the DP inequality. The redistributive payment may play a more important role in contributing to the equalization of total DPs per farm if it is applied by more MS and if it receives a greater share of CAP budget. Given that the vast majority of DPs are allocated based on land, any reform can only achieve equality per hectare or per farm, but not both. On the other hand, the legitimacy of an equal distribution of payments might be difficult to deliver from a political economy point of view because the application of the CAP support (including the level of the payment) might need to be tailored to local conditions, given that farmers (or rural community in general) face heterogeneous economic, social and environmental conditions across EU regions (d'Oultremont, 2011; Zwaan and Alons 2015). Moreover, as one of the main objectives of the CAP is to support the provision of ecosystem services, the DPs may need

to be redesigned in order to incentivise farmers in adopting environmentally friendly practices and to reflect the environmental spatial variability across the EU, which ultimately may or may not lead to a more equal distribution of subsidies (e.g. Brady et al. 2017).

The findings of our paper have to be considered with some caution given that the analyses did not consider potential effects coming from farm structural change, interaction among farms, production effects of DDPs, the reform effects on land rental prices and price-supply interaction between farm level behaviour and output market. Despite these limitations, our paper provides insights on the potential implications of the 2013-CAP reform for EU farms.

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522 **Figure 1. Average direct payments by MS (EUR/ha)**

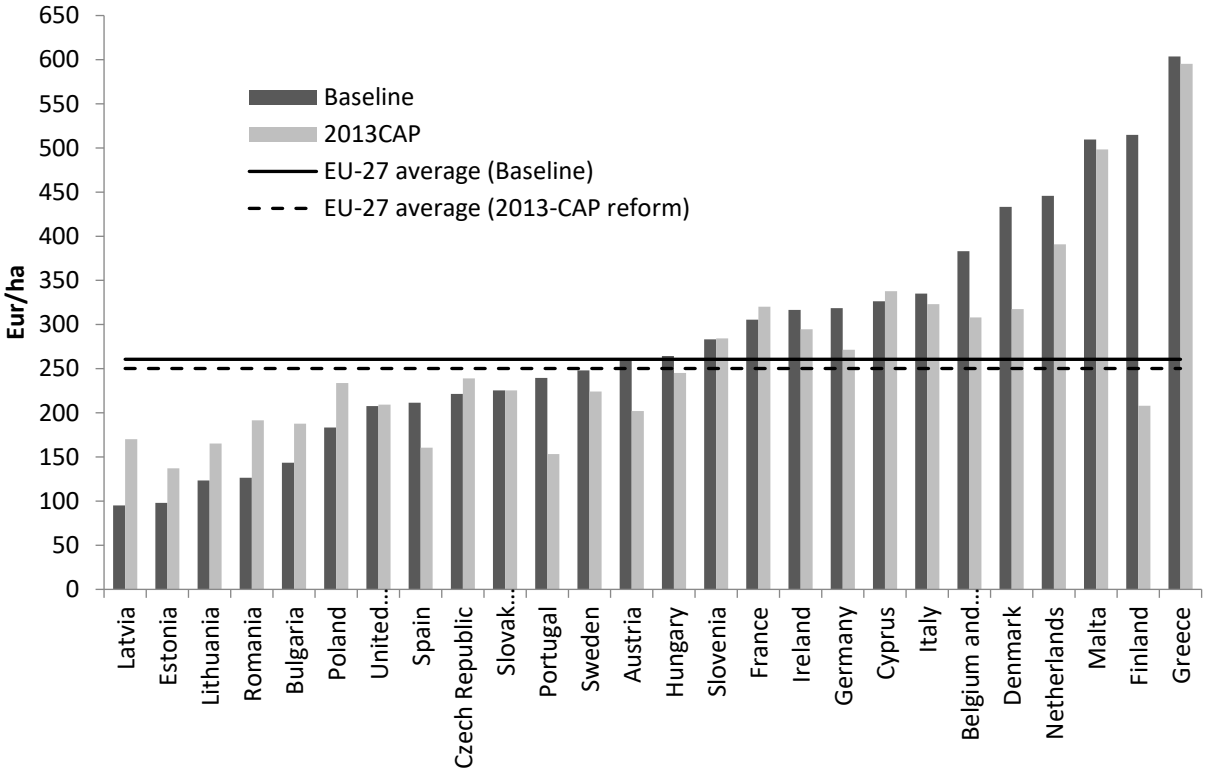

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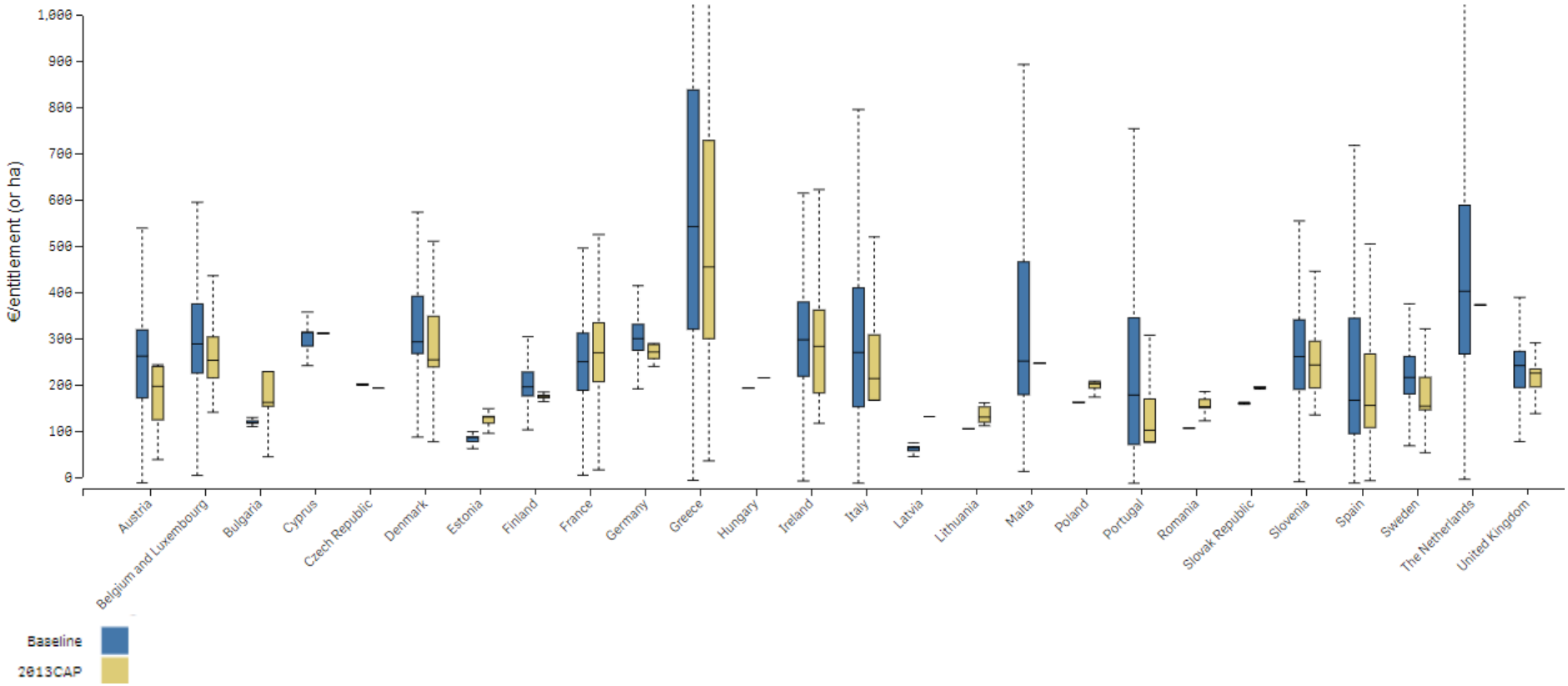
Figure 2. Distribution of decoupled payments across farms by MS (EUR/entitlement or ha)



Note: The bottom of each box-plot is the 25th percentile, the top is the 7th percentile and the line in the middle the 50th percentile or median. The whiskers represent the lowest datum within1.5 IQR (Interquartile Range) of the lower quartile and the highest datum still within the IQR of the upper quartile.

Table 1. Implementation of decoupled payments by MS in the pre- and post-reform periods

MS		Pre-reform model	Internal convergence			Redistributive payment			Capping	
			Model	% of direct payments budget	Territorial implementation	First hectares eligible (ha)	EUR/ha	% of direct payments budget	Thresholds (1000 EUR)	Reduction rate (%)
Belgium	WL	HM	PC	29.9	NM	30	115	17	150	100
(BL)	FL	HM	PC	56.8	NM				150	5
Bulgaria (BG)		SAPS	SAPS	47		30	77	7	150/300	5/100
Czech Republic (CZ)		SAPS	SAPS	54.8					150	5
Denmark (DK)		SHYM	PC	65	NM				150	5
Germany (DE)		DHYM	FR2015	62.1	RM*	1-30 /30-46	50/30	6.9		
Estonia (ES)		SAPS	SAPS	65.3					150	5
Ireland (IR)		HM	PC	67.8	NM				150	100
Greece (EL)		HM	PC	60	RM				150	100
Spain (ES)		HM	PC	56	RM				150	100
France (FR)		HM	PC	34	RM	52	25	20		
Croatia (HR)		HM	PC	43	NM	20	34	10		
Italy (IT)		HM	PC	58	NM				150/500	50/100
Cyprus (CY)		SAPS	SAPS	61.1					150	5
Latvia (LV)		SAPS	SAPS	55.1					150	5
Lithuania (LT)		SAPS	SAPS	38.3		30	50	15		
Luxembourg (LU)		SHYM	PC	68	NM				150	5
Hungary (HU)		SAPS	SAPS	54.8					150/176	5/100
Malta (MT)		RM	FR2015	12.4	NM				150	5
Netherlands (NL)		HM	FR2019	67.5	NM				150	5
Austria (AT)		HM	FR2019	65.9	NM				150	100
Poland (PL)		SAPS	SAPS	46		0-3/3-30	0/41	8	150	100
Portugal (PT)		HM	PC	47	NM				150	5
Romania (RO)		SAPS	SAPS	51		0-5/5-30	5/45	5		
Slovenia (SI)		RM	PC	54	NM				150	5
Slovak Republic (SK)		SAPS	SAPS	56.4	NM				150	5
Finland (FI)		DHYM	FR2019	49	RM				150	5
Sweden (SE)		SHYM	PC	55.4					150	5
United Kingdom (UK)	NI	SHYM	PC	68	NM				150	100
	EN	DHYM	FR2015	68	RM				150	5
	SC	HM	FR2019	61.8	RM				150/600	5/100
	WA	HM	FR2019	68	NM	54	128		150/200/250/300	15/30/55/100

Source: EC (2015)

WL=Wallonia; FL=Flanders; NI=Northern Ireland; SC=Scotland; WA=Wales; HM= historical SPS model; SHYM: static hybrid SPS model; DHYM: dynamic hybrid SPS model; RM: regional SPS model; PC=Partial Convergence; FR2015=Flat Rate by 2015; FR2019=Flat rate by 2019; SAPS=Single Area Payment Scheme; NM=National Model; RM=Regional Model. *In Germany the regional model will change to a national one in 2019.** In Sweden the flat rate will be achieved in 2020 (in 2019, our reference year for implementing the policy in the Baseline, there is partial convergence). *** FR-Corsica will apply a flat rate by 2015.

Table 2. The impact of the 2013-CAP reform on farm income by MS (% change relative to Baseline)

	Income change	Direct payments change
Austria	-2.63	-3.26
Belgium and Luxembourg	-2.32	-0.84
Bulgaria	7.43	5.28
Cyprus	-0.55	0.39
Czech Republic	-0.15	1.37
Denmark	-3.84	-2.38
Estonia	2.73	3.02
Finland	-7.82	-19.57
France	-0.96	0.63
Germany	-2.99	-1.79
Greece	-0.21	-0.29
Hungary	-0.89	-1.69
Ireland	-2.61	-1.03
Italy	-0.78	-0.30
Latvia	3.93	2.90
Lithuania	7.49	6.22
Malta	0.76	-0.08
Poland	6.04	4.87
Portugal	-7.92	-10.01
Romania	14.64	10.50
Slovak Republic	-2.78	0.00
Slovenia	-0.28	0.39
Spain	-4.43	-3.86
Sweden	1.06	-2.12
Netherlands	-4.09	-0.50
United Kingdom	-2.19	0.05
EU-27	-1.31	-0.42

Table 3. The impact of the 2013-CAP reform on farm income by farm type in EU-27 (% change relative to Baseline)

a) Farm specialization

Farm Specialization	Income change (%)	Std. Dev.
Mixed crops	-1.00	0.08
Mixed crops and livestock	-2.08	0.13
Mixed livestock	1.32	0.11
Permanent crops combined	0.18	1.98
Specialist cattle	-1.47	0.62
Specialist COP	-0.13	0.08
Specialist granivores	-1.34	0.25
Specialist horticulture	-2.32	0.06
Specialist milk	0.39	0.07
Specialist olives	-3.60	0.05
Specialist orchards - fruits	0.67	0.06
Specialist other field crops	-6.86	0.08
Specialist sheep and goats	2.27	0.49
Specialist wine	1.03	0.05

b) Economic farm size

Farm Size (in thousands €)	Income change (%)	Std. Dev.
2 - < 4	18.39	0.17
4 - < 8	7.75	0.10
8 - < 15	1.93	0.08
15 - < 25	-0.38	0.12
25 - < 50	0.30	0.10
50 - < 100	-0.72	0.10
100 - < 250	-2.06	0.05
250 - < 500	-2.45	0.06
500 - < 750	-1.48	0.04
750 - < 1 000	-1.69	0.05
1 000 - < 1 500	-2.24	0.06
1 500 - < 3 000	-4.86	0.06
>= 3 000	-4.14	0.07

Table 4. Gini decomposition by income source in EU-27

Income source	Share in total farm income	Gini coefficient	Gini correlation*	Share in total Gini**	Marginal change in Gini***
Baseline					
Market income	0.8751	0.8075	0.9926	0.9298	0.0547
Coupled payments	0.0163	0.8771	0.4674	0.0089	-0.0075
Decoupled payments	0.1085	0.6298	0.6763	0.0613	-0.0472
Total farm income	1.0000	0.7543		1.0000	
2013-CAP reform					
Market income	0.8784	0.8069	0.9938	0.9373	0.0588
Coupled payments	0.0100	0.7871	0.3540	0.0037	-0.0063
Decoupled payments	0.1116	0.5976	0.6653	0.0590	-0.0526
– BPS/SAPS****	0.0655	0.5955	0.6531	0.0339	-0.0316
– Greening payment	0.0392	0.6132	0.6722	0.0215	-0.0177
– ANC payments	0.0000	0.9999	0.4940	0.0000	-0.0000
– Redistributive payment	0.0069	0.8272	0.4789	0.0036	-0.0033
Total farm income	1.0000	0.7515		1.0000	

Notes: *Gini correlation: Gini correlation between the distribution of total farm income and specific income source. **Share in total Gini: contribution of specific income source to Gini. ***Marginal change in Gini: marginal change in Gini caused by specific income source (% change). ****Capping is implicitly included in BPS/SAPS.

Appendix: Model description

IFM-CAP is a constrained optimisation model. It assumes that farmers maximise their expected utility at given yields, product prices and production subsidies, subject to resource endowments and CAP policy constraints (Louhichi et al. 2018). Farmers expected utility is defined following the mean-variance (E-V) approach (Markowitz, 2014) with a Constant Absolute Risk Aversion specification (Pratt, 1964). According to this approach, expected utility is defined as 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). Farmers' expected income is defined as the sum of expected gross margins minus a non-linear (quadratic) activity-specific function (i.e. PMP 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 accounting costs include costs of seeds, fertilisers and soil improvers, crop protection, feeding and other specific costs. The quadratic activity-specific function is a behavioural function introduced to calibrate the farm model to an observed base year situation, 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; De Frahan et al., 2007; Heckelei, 2002). Regarding the income variance, we opted for considering uncertainty in revenues, but without differentiating between sources of uncertainty (Arribas et al., 2017) [21]. The general mathematical formulation of the IFM-CAP model can be written as follows (Louhichi et al., 2018):

Maximise $$E[U] = E[\boldsymbol{p} \circ \boldsymbol{y}]'\boldsymbol{x} + \boldsymbol{s}'\boldsymbol{x} - \boldsymbol{C}\boldsymbol{x} + \boldsymbol{e}\boldsymbol{t} - \boldsymbol{d}'\boldsymbol{x} - \frac{\mathbf{1}}{\mathbf{2}}\boldsymbol{x}'\boldsymbol{Q}\boldsymbol{x} - \frac{\boldsymbol{\varphi}}{\mathbf{2}}\boldsymbol{x}'\boldsymbol{\Sigma}\boldsymbol{x} \quad (1)$$

$$\boldsymbol{Ax} \leq \mathbf{b}\ [\rho]$$

$$\boldsymbol{x} \geq \mathbf{0}$$

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* vector 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 behavioral activity function, **Q** is the *I×I* symmetric, positive (semi-) definite matrix of the quadratic part of the behavioral activity function, φ is the farmer's constant absolute risk aversion coefficient and $\boldsymbol{\Sigma}$ 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 $\boldsymbol{\rho}$ is the *M×1* vector of the dual values associated with the resource constraints.

As shown in equation (1), decoupled payments, ***et***, are modelled in IFM-CAP as payments linked to land where the per hectare payment is the same regardless of how the land is used. This implies that decoupled payments in IFM-CAP are expected to increase farmers' income but they have no effect on farmers' land allocation decisions and production. In practice, however, decoupled payments may impact land use and production primarily in marginal areas. In general, empirical studies find rather small (negative or positive) or/and inconclusive production effects of decoupled subsidies (e.g. Goodwin and Mishra 2006; Bhaskar and Beghin 2009; Weber and Key 2012; Rizov et al. 2013; Kazukauska et al., 2014).[22]

[1] Note that the SAPS is only implemented in the New Member States (NMS), except for Slovenia and Malta that implemented the BPS. NMS (also referred to as EU-12) include: the Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Slovenia, Slovakia, Cyprus, Malta, Bulgaria and Romania. Old Member States (OMS) (also referred to as EU-15) include: Belgium, Luxembourg, Denmark, Germany, Austria, the Netherlands, France, Portugal, Spain, Greece, Italy, Ireland, Finland, Sweden and United Kingdom. EU-27 includes all EU Member States except Croatia. Croatia is not considered in this paper because it is not modelled in IFM-CAP due to data unavailability. Despite Brexit, the UK has been kept in the analysis. This is because at the time of conducting the analysis, the UK was a member of the EU.

[2] The eligible area includes any agricultural land which gives rights to DDPs. The eligible area has to be maintained under Good Environmental and Ecological Conditions (GAEC). The eligible area differs between the pre- and post-reform period and may not

exactly correspond to the total agricultural area as some crops are not eligible for DDPs (e.g. vineyards in France and greenhouses in the Netherlands and Greece are ineligible in the post-reform period).

[3] This implies that SPS and SAPS are decoupled from production, but not from land.

[4] The hybrid SPS models can be dynamic or static. The dynamic hybrid model is usually used as a vehicle to transition from the historical model to the regional (flat) rate model.

[5] The 2013-CAP reform aimed to create more equitable and targeted direct payments (EC, 2013). The term 'equitable' refers to a state where DPs are distributed in a way that seems fair to farmers or/and society, wherein the concept 'fair' implies a normative judgment. However, the CAP policy objectives are not specific on what 'equitable' actually means in the case of DPs. The policy debate is predominantly focused on the equality / inequality of DPs, either in terms of their distribution between beneficiaries or in terms of their value variation per hectare between farmers or MS (e.g. Schmid et al., 2006; EC 2017b). In this paper, we focus on equality / inequality of DPs. By 'equality' of DPs we refer to a state where there is a convergence in DPs (per farm or per hectare) between farmers or MS. Conversely, by 'inequality' of DPs we refer to differences in the distribution of DPs between farmers (per farm or per hectare) or MS.

[6] Espinosa et al. (2017) assess the effects of the 2013-CAP decoupled payments on farm income. However, this paper assumes a fixed production structure.

[7] The 2013-CAP reform replaced the SPS with the BPS. Similar to the SPS. The key difference between the SPS and the BPS is that the latter grants a basic layer of support to farmers which is topped-up by other payments targeting specific issues such as the redistributive payments, payments for ANC, etc.

[8] Malta exceeds the 13% threshold due to a derogation.

[9] CAPRI (Common Agricultural Policy Regionalised Impact) is a partial equilibrium and comparative static model for agriculture used for assessment of agricultural and trade policies with a main focus on the EU (Britz and Witzke, 2014).

[10] NUTS2 refers to regions belonging to the second level of the Nomenclature of Territorial Units for Statistics of the EU.

[11] The CAPRI Baseline is developed in conjunction with the European Commission (EC) Baseline. The EC constructs medium-term projections for the agricultural commodity markets on an annual basis. The projections present a consistent set of market and sectoral income prospects elaborated on the basis of specific policy and macroeconomic assumptions (Himics et al., 2013; Britz and Witzke, 2014).

[12] Note that the number of allocated entitlements might be lower than the total eligible land.

[13] Note that FADN is not constructed to be representative of direct payments (only on the number of farms per region, farm type and economic size class) therefore the total ceilings may be over/under-represented in the Baseline and in the scenarios.

[14] In MS which implement BPS decoupled payments are divided by the total number of entitlements, whereas in MS with SAPS the decoupled payments are calculated per total agricultural area. In MS having entitlements when referring in the text 'per hectare' it refers to eligible hectare accompanied by one entitlement.

[15] For an application of the approach of Lerman and Yitzhaki (1985) for CAP, see for example Severini and Tantari (2013).

[16] According to 2012 FADN data, the average area per farm in EU (share in total EU agricultural area) is 68 ha (27%) for specialist COP farms, whereas for specialist milk, specialist sheep and goats, specialist cattle and specialist granivores it is 37 ha, 38 ha, 50 ha and 38 ha, respectively (13%, 10%, 12% and 3%, respectively).

[17] The production effects by farm type are larger because some farm types have low production in the Baseline, particularly for activities in which they are not specialised implying that a small change in absolute value leads to a larger change in relative terms.

[18] Income is calculated as the difference between total revenues (production sales and subsidies) and variable costs (e.g. expenditures on fertilizers, pesticides, seeds, feeding). Note that the effect of the reform on the land rental prices is not modelled in IFM-CAP, hence we report direct income effects in this section without accounting for the induced changes in land rental costs.

[19] Note that income is represented in nominal terms in IFM-CAP. However, income changes reported in this section refers to changes between the reform scenario and Baseline where everything else is kept unchanged. This implies that inc
ome changes reflects the effect of the reform.

[20] Note that the decomposition results for income and those reported for DPs in the previous section are not directly comparable because the variables analysed in each case are different.

[21] The risk component was not indispensable for this paper and conceptually could be embedded in the PMP function without any significant impacts on model results.

[22] The negative impact of subsidies on production may result from the allocative and technical efficiency losses due to soft budget constraints or reduced farm structural change (e.g. Brady et al, 2017; Kornai 1986). The positive impact of subsidies may be due to, e.g., the investment-induced productivity gains caused by the interaction of credit and risk attitudes with decoupled subsidies (subsidy-induced credit access, lower cost of borrowing, reduction in risk aversion) (e.g. Hennessy 1998).