



## JRC TECHNICAL REPORT

# The Regional Dimension of the CAP: 2007-2018

Competence Centre on Microeconomic  
Impact Evaluation (CC-ME)

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## **Abstract**

The Common Agricultural Policy (CAP) is one of the main pillars in constructing the European project. Since 1962, the CAP has evolved from its traditional role of supporting farmers' livelihood and improving agricultural productivity to embrace balanced territorial development. In the process, it has been implemented across the EU territory in a fashion tailored to the regions' needs. This report explores a rich data set on disaggregated CAP payments and regional characteristics to describe the regional dimension of the CAP. It does so by identifying and quantifying three relevant dimensions of the policy: the time dimension, associated with the reforms it has undergone in the period of analysis; the spatial dimension by framing its implementation in the rurality context of the EU territory and; the mix dimension by typifying the different implementation models of the policy. This characterization of the CAP and its rural context allows to investigate the regional patterns of its implementation. The study finds clear evidence that the more developed regions tend to benefit from policy mixes with a relatively low contribution from Pillar 2. On the other hand, developing and less developed regions tend to implement a mix of instruments that privilege rural development actions.

## **Acknowledgments**

The authors appreciate the contribution of Annalisa Frigo in the early stages of this project and thank Pierre Boulanger from JRC.D4 for fruitful exchanges on the CAP funds classification.

## **Forward**

This report is the result of a collaboration between the Competence Centre on Microeconomic Evaluation (CC-ME) within JRC.I.1 “Monitoring, Indicators & Impact Evaluation” and DG AGRI.C.4 “Monitoring and Evaluation” through a Joint Work Programme on “Testing Evaluation Methodologies in Common Agricultural Policy (CAP) evaluation”.<sup>1</sup>

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<sup>1</sup>Ref.Ares(2019)7712473-16/12/2019

# Executive Summary

## Policy context

The Common Agricultural Policy (CAP) has been, since its origin in 1962, one of the main EU policies. Its spending programmes amount to approximately one-third of the European Commission budget. Through the decades, the CAP has undergone several waves of reforms to adapt the policy to the challenges the agricultural sector was facing and the need to promote the socio-economic development of rural areas. These reforms shaped the policy in many distinct directions.

Currently, the CAP is financed by the European Agricultural Guarantee Fund (EAGF) through direct (income) support and market measures and the European Agricultural Fund for Rural Development (EAFRD) that promotes rural development policies. Together they constitute the two pillars of the EU strategy to support farmers involved in ensuring continued access to high-quality food for the EU citizens and local agents promoting rural development.

An important feature of the CAP reforms is the increasing number of instruments available to farmers and regions in both Pillars. Some address the specific needs of certain regions, such as Least Favoured Areas, while a wide choice of measures is at the disposal of all the regions. In addition, Member States can shift resources across the two Pillars to finance their rural development policies in the current CAP. As a consequence, the EU28<sup>2</sup> regions exhibit a diversity of CAP implementation models. As mentioned by the Agricultural and Rural Convention (ARC2020), “As a result for some, the CAP would seem to be less “common” and be more “à la carte.”<sup>3</sup>

The different models of CAP support implementation depend on the farming sector and socio-economic characteristics of the regions. These two elements can be summarized in a rurality concept defined in the CAP context and can be observable at a regional level.

The characterization of the heterogeneous EU rural space is an essential input to understand the coherence and efficacy of the CAP funds allocation.

## Objective of this study

Policymakers have to consider the demands of EU regions for different types of support when deciding future reforms and spending priorities. The CAP and its reforms have produced implementation patterns that are heterogeneous across space and time. Therefore, studying

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<sup>2</sup>The study regards the EU28 regions, included the UK, which left the EU on 31 January 2020. The analyses based on variables related to the CAP do not include Croatia before joining the EU, in 2013.

<sup>3</sup>ARC2020. 2021. <https://www.arc2020.eu/cap-reform-towards-2020-pillar-1-direct-payments-implementation-by-eu-member-states/>

this heterogeneity and characterizing it in terms of CAP funds composition and type of NUTS 3 regions' rurality is essential from a policy-decision-making perspective.

This report provides a regional characterization of the CAP in the period 2007-2018 based on NUTS3 level data for the EU28 Member States (the UK left the EU on 31 January 2020). By analyzing CAP expenditure at such a territorial disaggregation level, it provides insights on the policy implementation patterns induced by the reforms and relates it to the territorial characteristics of the regions.

The study aims at providing a framework that describes the CAP implementation at a regional level by considering three relevant dimensions. First, the *time* dimension of the CAP is characterised by analysing the change induced by the CAP reforms in the composition of the funds allocated to the EU NUTS 3 regions. This is used to define time intervals that characterise the policy. Second, the *policy mix* dimension is identified by describing in each time interval the different combinations of selected groups of Pillar 1 instruments and Pillar 2 measures. These correspond to the regions' set of CAP implementation choices. Third, the *spatial* dimension of the EU28 is analysed by developing rurality measures that relate to the CAP implementation. These capture several dimensions of the NUTS3 regions' rurality, such as local economic, territory and agricultural sector.

The report exploits these three dimensions to describe the regional dimension of the CAP. It addresses how the regions' implementation choices relate to their rurality degree and; how the CAP reforms in the period 2007-2018 promoted changes in those choices.

## Findings

The CAP funds composition between 2007 and 2018 suggests dividing the overall period into three *Reform Based* time intervals: (a) 2007-2010, *pre-Health Check*, with a relatively high proportion of Coupled Direct payments and low Pillar 2 expenditure; (b) 2011-2015 *post-Health check*, with relatively more Decoupled Direct payments and an increase in Pillar 2 expenditure; (c) 2016-18, characterized by the Greening reform. These intervals hide a high degree of regional heterogeneity in the adoption of those reforms. In particular substantial differences are found between the groups on New Member States (NMS) and Old Member States (OMS) and across regions with different EUROSTAT urban classifications.

The report typifies how the EU28 NUTS3 regions combined Pillar 1 measures and Pillar 2 instruments in the three reform-based sub-periods, thus providing spatial distribution of the CAP policy mixes. In the period 2007-2010, most regions of the Old Member States (OMS) belong to clusters characterized by a relatively strong intensity of Pillar 1 measures. On the other hand, the New Member States (NMS) are classified as relatively strong on Pillar 2 measures. In the period 2011-2015, there is a general increase in the Pillar 2 expenditures, even if some regions in the NMS and southern OMS, which were characterized as strong in Pillar 2 in the



previous period, seem to get more Direct Payments. In the third period, the “Pillar 2 revolution” is accompanied by an increase of Pillar 1 expenditures, and NMS, traditionally strong on Pillar 2 investments, attain Decoupled payments.

The study also analyses the rurality nature of EU NUTS3 regions’ for each period. The analysis classifies the EU territory to the following rurality clusters: (1) *Dynamic regions based on services and capital intensive agricultural sector*, (2) *Developed highly innovative semi-urban regions*, (3) *Non-diversified forest based regions*, (4) *Attractive forested regions with high labour productivity* (which become *Attractive semi-urban regions with large agricultural areas* in 2015), (5) *Less developed remote regions with low agricultural labour productivity* (which become *Attractive semi-urban regions with large agricultural areas* in 2010, and *Unattractive agricultural rural areas* in 2015), (6) *Developing regions with mixed economies*, (7) *Depleting regions*, and (8) *Predominantly urban regions*.

This study finds clear evidence that the more developed regions (‘Predominantly urban regions’, ‘Dynamic based on services and capital intensive Agri’, ‘Developed highly innovative semi-urban’, and ‘Attractive forested regions with high labour productivity’) tend to benefit from policy mixes with a relatively low contribution from Pillar 2. On the other hand, developing and less developed regions (‘Developing with mixed economies’ and ‘Depleting regions’) exhibit policy mixes where the Pillar 2 programs (either ‘Strong Pillar 2-Low Pillar 1’, or ‘Very Strong Pillar 2’, or ‘Strong Direct Payments’) play an essential role. This pattern appears stable across clusters and sub-periods, except for ‘Developing with mixed economies’ territories, which partly begin to benefit from Pillar 1 programs during the last considered years. Another interesting finding is that in 2007-2010 the ‘Developed highly innovative semi-urban’ regions were receiving relatively low Pillar 2 and high Pillar 1 funds. This pattern seems to be different in the following two periods (2010-15 and 2016-18), where the regions in this rurality cluster benefit also from strong Pillar 2 measures.

## **Quick guide**

This report exploits the availability of a rich data set on disaggregated CAP payments and territorial characteristics to provide a NUTS3 level description of the policy along the time, policy mix and spatial dimensions.

The *time* dimension identifies three moments in the policy that have led to changes in the regions’ implementation choices: The 2009 Health Check (2007-2010), The 2013 CAP Reform (2011-2015), and The “Greening Reform” (2016-2018).

The *policy mix* dimension, corresponding to the implementation patterns of the CAP, are characterised using a Principal Components Analysis (PCA) and hierarchical cluster analysis on Pillar 1 and Pillar 2 groups of measures. These were constructed to allow comparisons across programming periods and measured as intensities (relative to the region’s GVA) to enable

comparisons across regions. In particular, the Pillar 1 instruments were classified according to their nature regardless of the specificity of the payments schemes.

The *rurality* dimension was described by two cluster analyses. The first characterises the EU28 NUTS3 regions according to a multidimensional approach based on indicators of the local economy, agricultural sector, demographics, innovation, land use and remoteness. The second cluster analysis characterised the agricultural dimension of rurality and used the sectoral and land use indicators.

# 1 Introduction

The Common Agricultural Policy (CAP) is one of the main EU policies together with the Cohesion Policy. Both policies have historically employed two thirds (approximately the same proportion) of the European Commission budget. The Multiannual Financial Framework 2014-2020 allocated 38% of its total amount to the CAP to finance direct payments to farmers, market measures and rural development programmes. An essential element of the policy is direct payments, which covers the 72% of the overall CAP budget in the current programming period.

The CAP has been introduced in the 1980s mainly as a market intervention through price support. Since its first reform in 1992, the policy has seen a continuous progressive transformation towards a type of support less linked to the quantity of production and more linked to the territory. More specifically, in origin, the CAP payments were tied to the production of fixed yields (crops) or numbers of animals ('coupled payments'). The MacSharry reform in 1992 and the Agenda 2000 reform reduced price support, and respectively introduced and increased "compensatory" payments not linked to production, i.e. *decoupled*, as basic income support for farmers. The Fischler reform in 2003 introduced the "Single Payment Scheme", i.e. payments linked to the land but not to how much nor to what it produced. In addition, the Council Regulation 1290/2005 defined two distinct funds for financing the CAP: the European Agricultural Guarantee Fund (EAGF) and the European Agricultural Fund for Rural Development (EAFRD). Pillar 1 (EAGF) finances direct payments to farmers and measures to respond to market disturbances (e.g. private or public storage and export refunds). Pillar 2 (EAFRD) supports the EU Member States' rural development programmes. Both Pillars replaced the European Agricultural Guidance and Guarantee Fund (EAGGF), which had been set up by Regulation 25/1962 on the financing of the CAP.<sup>4</sup>

The latest CAP reform (2013) maintained the two 'pillars' structure for the policy and introduced new flexibility for MS in allocating funds between pillars.<sup>5</sup> The two other main elements of innovation of the reform were: (i) the introduction of a new system of direct payments -"Basic Payment Scheme"-, consisting of a basic component of income support and other components that remunerate both specific farm behaviours (30% of the direct support, the *greening payments*, are linked to environmental and climate action objectives) and specific status (being a young farmer, farming in the area with natural constraints etc.); (ii) making direct support per hectare converge across Member States (*external convergence*) and within Member States across regions (*internal convergence*), to achieve a 'fairer and more equitable distribution of the support'.

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<sup>4</sup>While the Pillar 1 instruments are of supra-national nature (they are decided and financed entirely by the EC and apply equally to MS), Pillar 2 measures are selected and co-financed by the MS. This results to higher diversification in the nature and composition of Pillar 2 policies across the EU NUTS 3 regions.

<sup>5</sup>The Member States can transfer up to 15% of money from Direct Payments to Rural Development and vice versa, or up to 10% from EAFRD to Direct Payments if Direct Payments are less than 90% of the EU average.

The CAP 2014-2020 thus focused on greener and more equitably distributed direct payments classified under Pillar 1 and launched important Pillar 2 interventions related to competitiveness and innovation, climate change and the environment. The 2016-2020 period has also been characterised by a reduction in Pillar 1 and Pillar 2 nominal expenditures (by 13% and 18%, respectively) overall, and as a result of the convergence principle, some Member States traditionally receiving a high level of funds have seen a reduction in the total amount of CAP while the opposite is true for MS that entered the EU more recently.

This report addresses the research question: What are the implications of the above reforms on the MS CAP implementation patterns policies? Given the multitude of CAP instruments and measures and the economic heterogeneity of the EU territory, how to best characterise it?

Studying this heterogeneity and characterising it in terms of CAP funds and type of regions' rurality is essential from a policy-decision-making perspective. Characterising the heterogeneous EU rural space and its evolution over time is an essential input to analyse the coherence and effectiveness of CAP funds allocation.

This report analyses in a multidimensional framework how the CAP measures have been mixed and spatially distributed in the period 2007-2018.

The report is structured as follow. Section 2 exploits the changes induced by the CAP reforms in the composition of the funds allocated to the EU NUTS 3 regions to define time intervals that characterise the policy (as this report goes out in 2021, it is appropriate to note that the UK is no longer an EU Member State). Section 3 characterises the implementation patterns of the CAP policy measures during the period 2007-2018 using a Principal Components Analysis (PCA) and a hierarchical cluster analysis. Section 4 develops a rurality measure that captures various dimensions of the EU NUTS 3 regions, such as structural, socio-economic, territorial/geographical and agricultural. Section 5 analyses the composition of the CAP clusters across the rurality clusters. Finally, section 6 reports some concluding remarks.

## 2 The CAP's time dimension: 2007-2018

In the period considered in this analysis (2007-2018) the CAP as an income support and rural development policy has gone through several reforms. These were introduced with the new Programming Period (PP) or/and at moments where the policy priorities were redefined. These reforms put at the disposal of farmers and regions new instruments and measures to pursue the objectives of the policy. As a result, the composition of both Pillar 1 measures and Pillar 2 instruments allocated to the regions changed over time.

This section investigates the change induced by the CAP reforms and exploits the composition of the funds allocated to the regions to define time intervals that characterise the policy. The analysis accounts for two determinants of the funds' composition: Firstly, the distinction between the CAP profile of the Old Member States (OMS) and the New Member States (NMS) and; secondly, the spatial heterogeneity in the CAP implementation models across types of regions, here described by the EUROSTAT regional typologies.

### 2.1 The CAP reforms in the period 2007-2018

In the period 2007-2018 it is possible to identify key moments in the policy that bound to induce changes in the regions' implementation choices:

- **The 2009 Health Check:** The elimination of the distortions induced by coupled payments has been an objective of the CAP policy since the 2003 *Fischler Reform*. The 'Health Check' further reinforced the decoupling by introducing the *Single Payment Scheme*. This means that the decoupling of the CAP, can not be placed in just one moment in time, but its implementation should be monitored across consecutive time intervals. In addition, this reform introduced the concept of 'modulation'. This allowed and promoted the shift of Pillar 1 financial resources to Rural Development measures, i.e., Pillar 2. There is a link between the two features of the reform as MS applying the *Single Payment Scheme* were allowed to transfer unused commitments to the Rural Development Fund.
- **The 2013 CAP Reform:** This reform maintained the two 'pillars' structure for the policy and introduced new flexibility for MS in the allocation of funds between pillars. Two new priorities for the 2014-2020 Programming Period were introduced: a greener policy, and the promotion of a more equitable distribution of direct payments under Pillar 1. In addition, Pillar 2 instruments evolved to allow a more integrated, targeted and territorial approach to rural development. The broad outlines of the CAP for this period bound to have budgetary consequences were:
  - Targeting of decoupling direct aid to specific objectives related to seven components (the first three obligatory): Basic payment, Greening payment and Young farmers

payment are obligatory, Redistributive payment, Support for Areas with Natural Constraints, Coupled payments and a Small Farmer Scheme.

- External Convergence of direct payments to guarantee a greater uniformity between MS, and in particular between OMS and NMS;
- Consolidation of the two Pillars and enhancing of Inter-pillar flexibility and;
- Introduction of a new set of Pillar 2 instruments related to *Competitiveness & Innovation* and *Climate change & Environment*.

- **The 2016-2020 Greening Reform:** The CAP revision for this period was characterised by a reduction in Pillar 1 and Pillar 2 nominal expenditures (by 13% and 18%, respectively) and an increase of payments to environmental measures. Following these reforms, some Member States traditionally receiving a high level of funds have seen a reduction in the total amount of CAP while the opposite occurred in MS that entered the EU more recently (external convergence) and *Greening* represents up to 30% of Pillar 1 direct payments.

## 2.2 A reform based approach to the CAP timeline

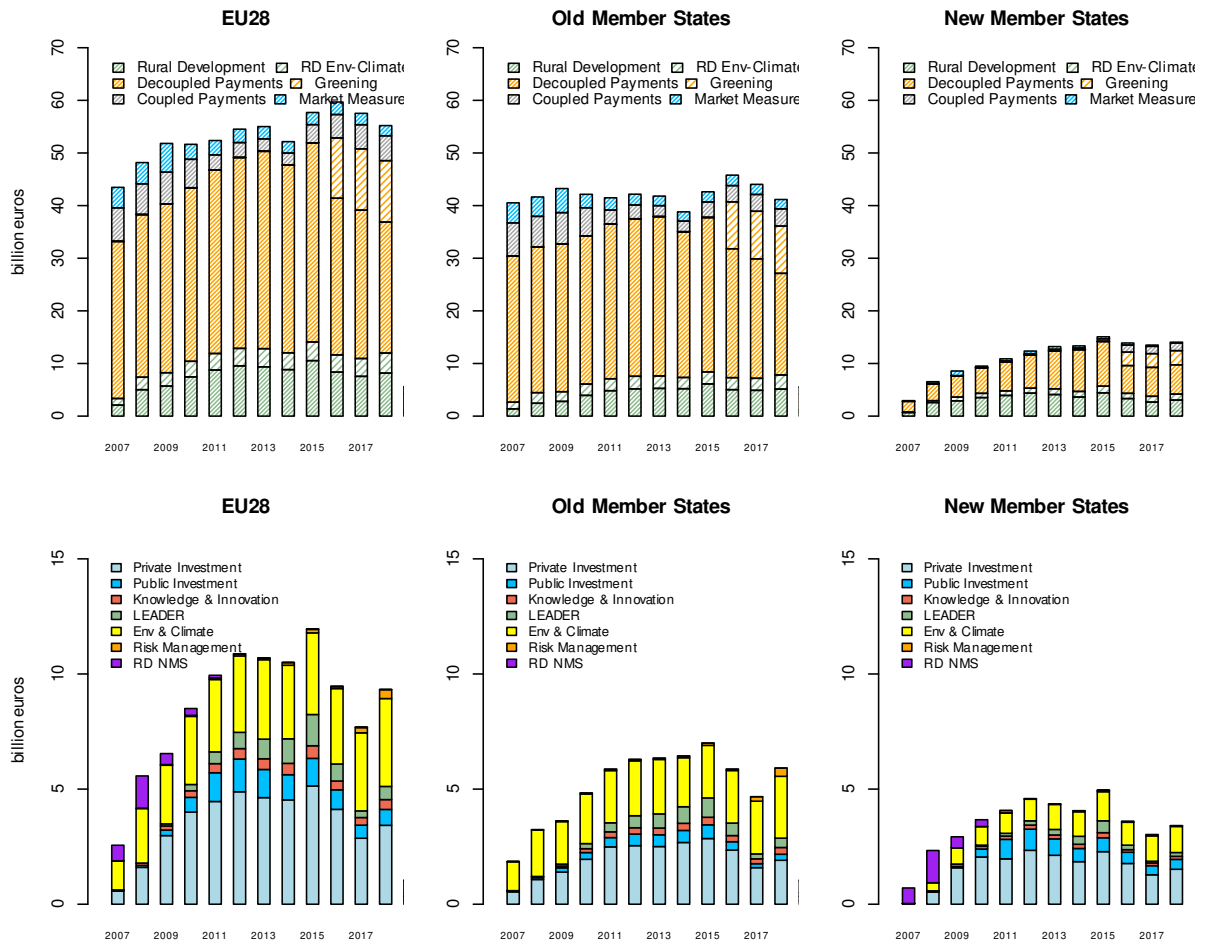
Figure 1 shows how CAP payments by groups of Pillar 1 and Pillar 2 measures and by groups of MS (first column EU28, second column OMS and third column NMS) evolved between 2007 and 2018. The first row shows the Pillar 1 payments, *Coupled*, *Decoupled* and *Market Measures* and, Pillar 2 *Rural Development* and *Environmental & Climate*. The histograms illustrate the change in CAP payments composition: in this period the share of Pillar 2 payments increased; within Pillar 1 the increase of the decoupled payments share until 2016 is made at the expense of both coupled payments and market measures and from 2016 onward the Greening payments have been introduced and the coupled payments have registered a significant increase.

The second row shows a disaggregation of the Rural Development funds. Despite the fact that *Environmental & Climate* measures represent the highest share of Pillar 2 payments, the *Private* and *Public Investment* group is responsible for a considerable increase in the Pillar 2 payments. Similarly, the increase of LEADER expenditure is relatively high in this period.

The overall CAP expenditure composition of the OMS differs significantly from the NMS, reflecting the historical nature of the CAP as an income support policy and the recent shift towards rural development policies. Concerning the latter, while the profile of Pillar 2 expenditure in the OMS is dominated by *Environmental & Climate* measures and *Private Investment*, in the NMS the *Public Investment* share is also important.

Despite the specificities in the time-line of Pillar 1 payments across the two groups of countries, overall they are characterised by three time intervals: (i) 2007-10, where the proportion

Figure 1: Total CAP payments by groups of Pillar 1 and Pillar 2 and countries



Note: Env (Environment); RB NMS (Rural Development New Member States).

of Coupled direct payments is relatively high; (ii) 2011-2015, where their share payments reduces considerable and; (iii) 2016-18, where it again increases and the introduction of the Greening (decoupled) payments is linked to an overall reduction of Pillar 1 funds. On the other hand, the overall path of Pillar 2 payments is similar across the two groups of countries, although their composition differs. The payments under Pillar 2 exhibit a steep increasing path until 2010, stabilise in the subsequent three years and decrease (on average) in the 2016-2018 interval.

The analysis of the CAP payments composition suggests a *Reform Based Approach* to define three CAP implementation sub-periods in the interval 2007-2018:

1. The period 2007-2010: It is the pre-*Health Check* 2009 reform period. It is characterised by the CAP model before this reform and is the baseline for the subsequent period, denot-

ing a relatively high proportion of Coupled Direct payments and low Pillar 2 expenditure;

2. The period between 2011-2015: The CAP payments in the period post-*Health Check* reform, brings evidence of the Decoupling of direct payments and an increase in Pillar 2 expenditure;
3. The period 2016-18: It is mainly characterised by the 2016 Greening reform promoted although being associated with other features of this 2013 reform, such as the external convergence. Paradoxically while the CAP historically been promoting the decoupling of direct payments, in this period, the share of *Coupled* payments increases in both NMS and OMS.

Although these periods are based on the measures and instruments stemmed from the CAP reforms, the profile of the CAP expenditure reflects mainly the MS and regions' choices. This is because the policy allows for a high degree of flexibility in the way the beneficiaries adhere to the proposed reforms. The next subsections illustrate the heterogeneity of the CAP implementation in these periods.

### **Decoupling and Rural Development**

The reform based approach that characterises the CAP intervals is strongly linked to the changes in the balance between coupled and decoupled payments and on the propensity to invest in rural development. The adoption of these reforms depends largely on the regions' economic profile. It is used to identify to what extent the regions changed their CAP profiles concerning these two dimensions.

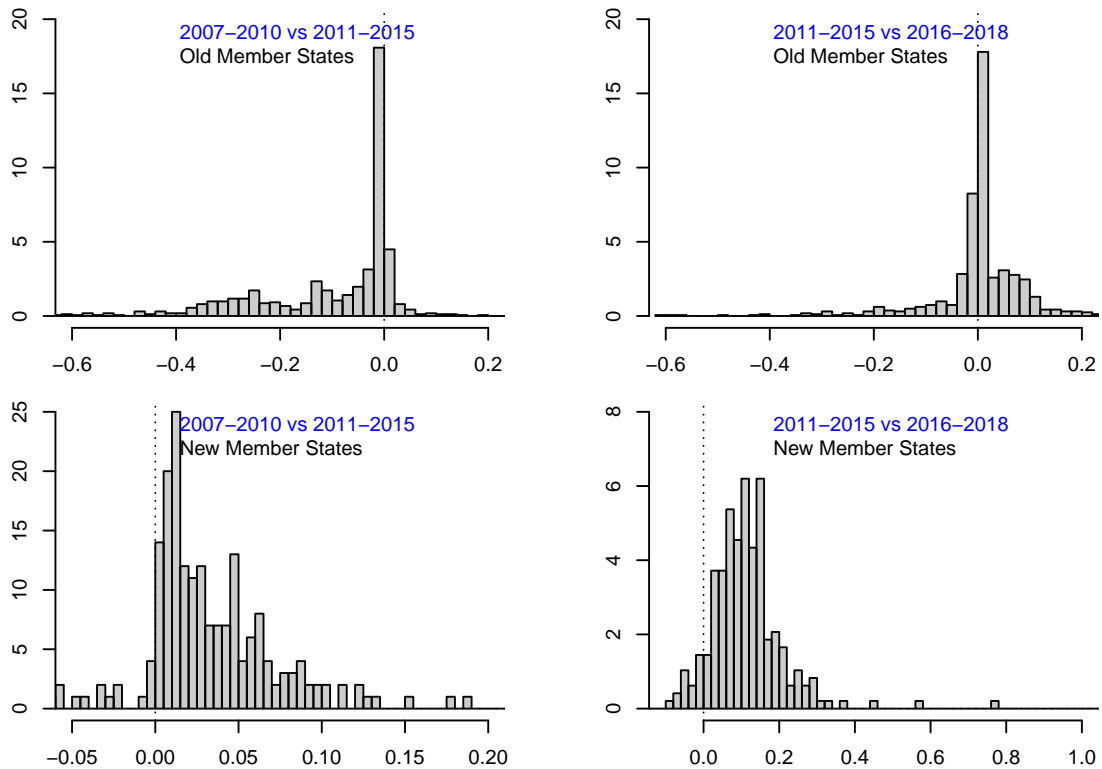
The variations of the Coupled to Decoupled payments ratio during the time interval 2011-2015 compared to the respective figures for the intervals 2007-2010 and 2016-18, for both OMS and NMS are shown in Figure 2a. As expected, the first panel confirms that the decoupling orientation from '2009 Health Check' was addressed to OMS only, since NMS did not historically receive large amounts of Pillar 1 payments. The histograms show that while a considerable proportion of the OMS regions did not change their Coupled/Decoupled composition, others decoupled these direct payments with different levels of intensity. In the second interval, characterised by the 2013 CAP reform, again while most regions did not change this ratio, some continued decoupling while others increased their coupled payments.

Figure 2b shows the variation of the average Pillar 2 to average Pillar 1 ratio across the periods. The histograms reflect the extent to which the regions invested in rural development. Again the two groups of countries' variation simply reflect their baseline CAP profile. While the OMS start from a traditionally high intake of Pillar 1 measures, the NMS do not have this historical record. As a consequence, the OMS histograms show that the Pillar 2 revolution affected almost all regions of OMS and a nonnegligible part of NMS in the first period. In the second

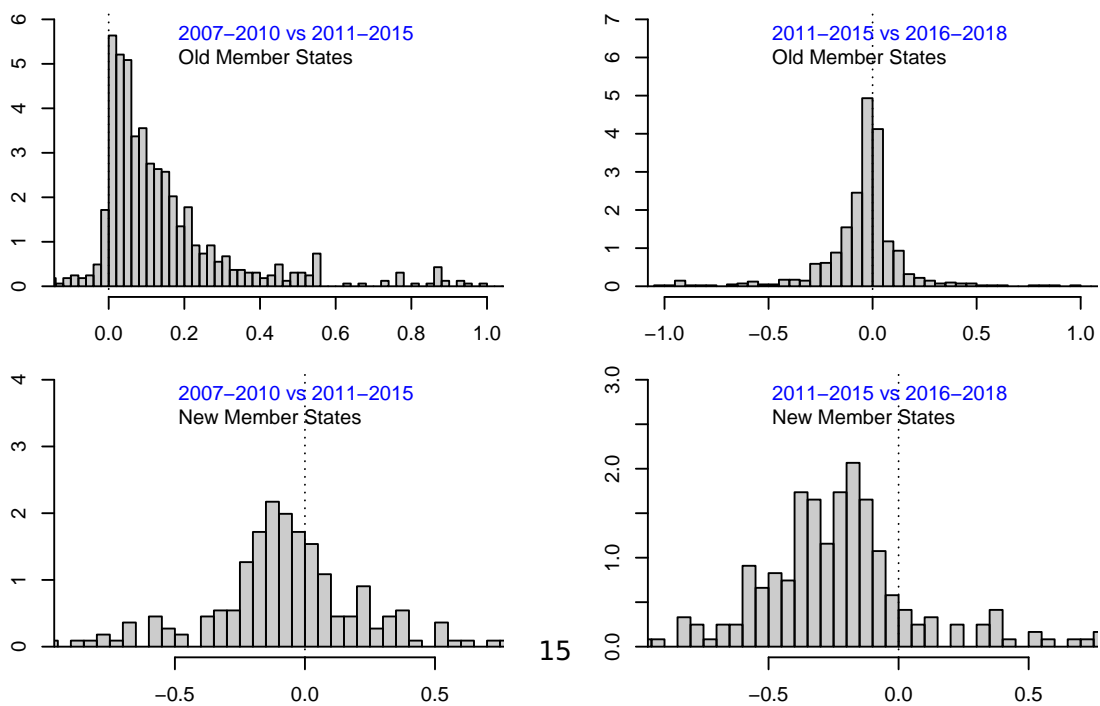


Figure 2: Histograms of Coupled to Decoupled Direct Payments and Pillar to Pillar 1 ratios variation across periods.

(a) Histogram of Coupled to Decoupled Direct Payments ratio variation across period: Old Member States and New Member States



(b) Histogram of Pillar 2 to Pillar 1 payments ratio variation across periods: Old Member States and New Member States



period, the increase of Pillar 2 as compared to Pillar 1, is weaker than in the previous and continues to regard the regions of OMS more frequently than the regions of NMS.

### **Regional heterogeneity**

The figures on the CAP implementation at the EU level hide a high degree of heterogeneity across countries and within countries. As such, it matters to further consider the different implementation models taking into account the economic context of the two groups of countries and the regional typologies within them.

This section introduces two additional dimensions of the CAP implementation. First, both funds are measured relative to economic and agricultural regional dimensions. Second, the regional typologies are considered by adopting the EUROSTAT classification, to possibly shed some light on the territorial nature of the CAP implementation.<sup>6</sup>

Figure 3 and Figure 4 show Pillar 1 and Pillar 2 funds categories for respectively the group of OMS and NMS, measured as amounts of funds and as a proportion of *Agricultural Area (AA)*, regional GDP and, regional GVA in the agricultural sector. In addition for each period three regional typologies are considered: Predominantly Urban (Urb), Intermediate (Int), Rural close to city (Rur1) and Remote Rural (Rur2).

The figures reveal a different regional pattern of the CAP implementation between the two groups of countries. In the OMS the CAP funds regional distribution is relatively stable over time, both in absolute terms (Euros) and as relative measures (Fig. 3). This regional perspective allows to further characterise the time evolution of the balance between *Coupled* and *Decoupled*.

When considering the regional distribution of the funds, in this group of MS, the CAP funds are equitably distributed relative to the agricultural area, although they benefit more rural economies and in particular their agricultural sector.

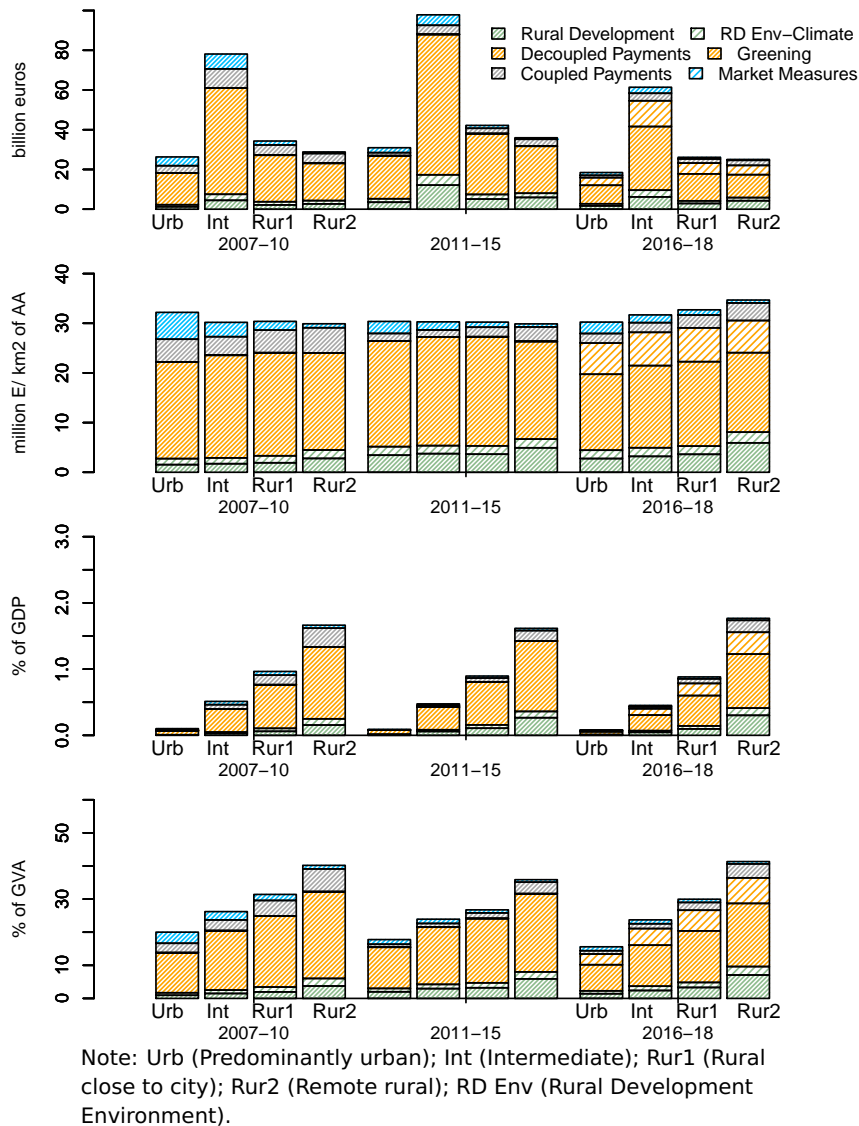
In the group of NMS (Fig. 4) the total amount of CAP funds and in particular the first Pillar increased until 2015 as a result of the 'external convergence' objective of the CAP. In this group, *Intermediate* and *Rural close to city* are the main beneficiaries of the CAP funds. However, the *Urban* areas get, until 2015, a higher share of both Pillars with respect to the physical (measured by the AA) and economic size (measured by the GVA in the Agri sector) of their agricultural sector.

Figure 5 and Figure 6 show absolute and relative Pillar 2 payments by measures and by regional typology for respectively OMS and NMS. The figures show how in both groups Pillar 2 payments have increased in this period although with different regional patterns. In the OMS, although

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<sup>6</sup>The EUROSTAT regional classification does not provide a satisfactory characterisation of the EU28 regions as it is mainly based on population density. However, it will be adopted in this context as evidence of the need to further explore the CAP regional dimension.

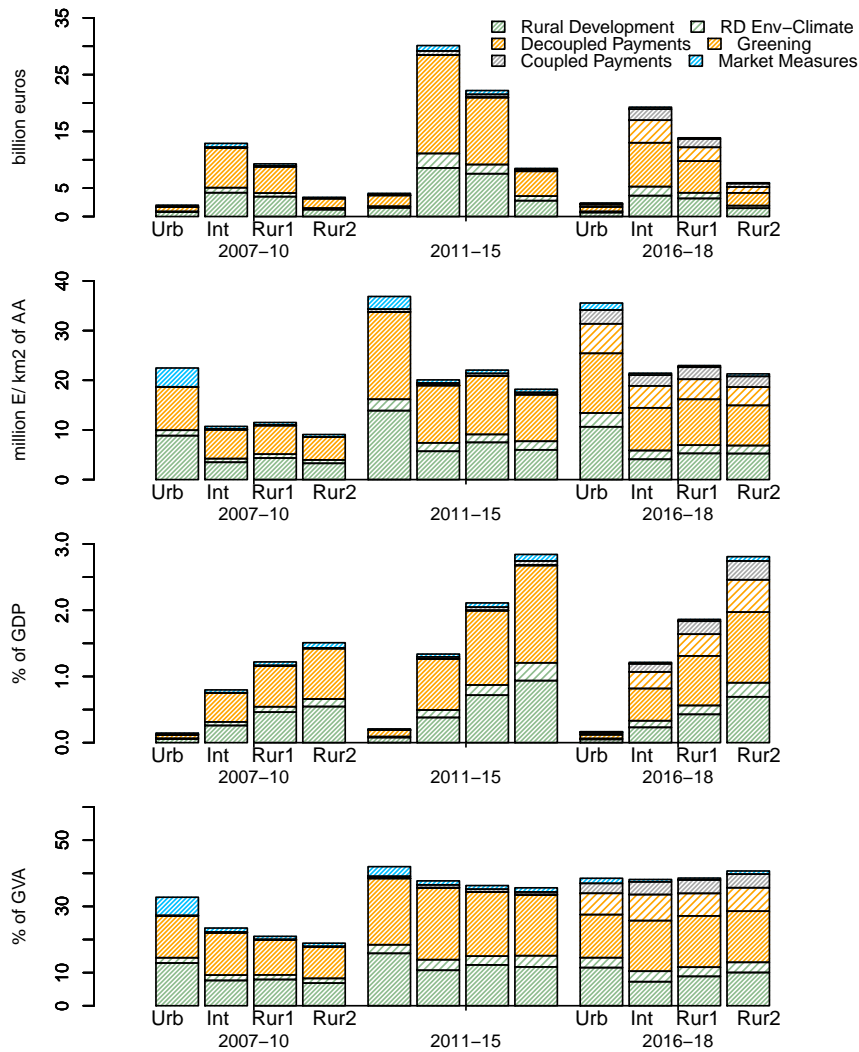
Figure 3: CAP payments intensities by category and regional typology:  
Old Member States



equitably allocated with respect to the AA, these funds tend to benefit more rural areas in both agricultural related dimensions (GVA in agriculture) or with respect to overall economy (regional GDP). In contrast to this pattern, the NMS Pillar 2 funds tend to benefit more urban areas in the agricultural dimensions.

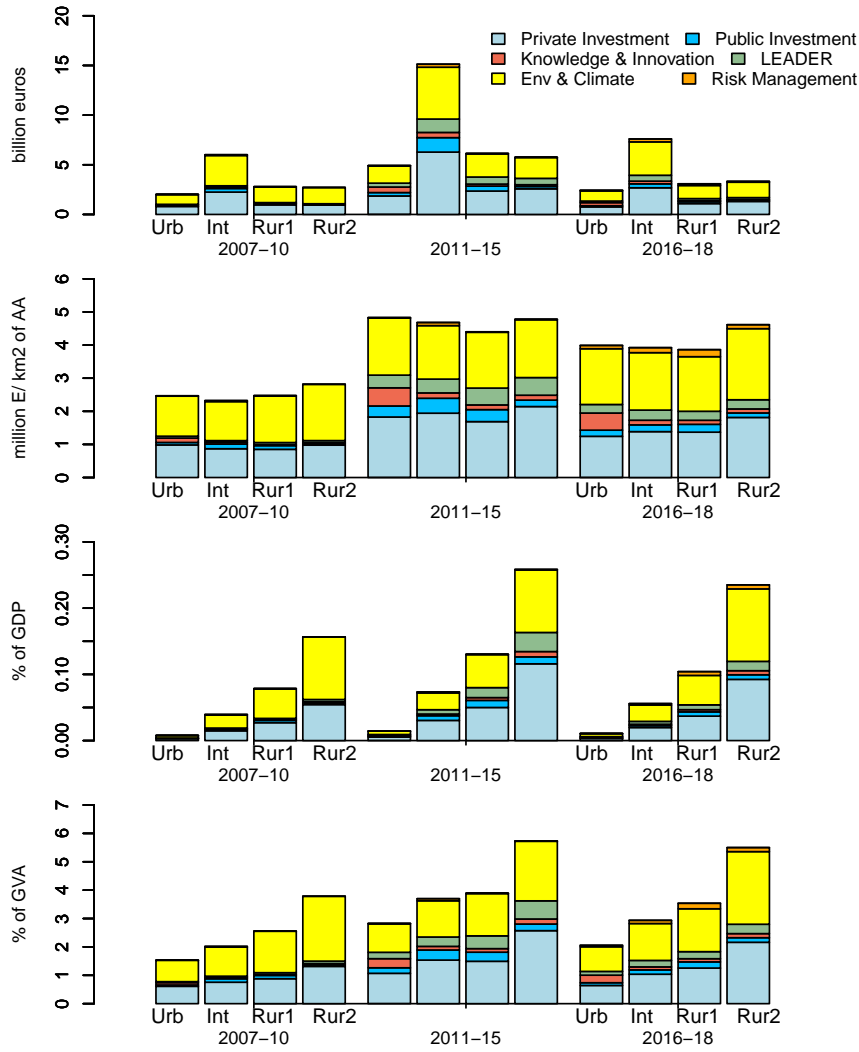
An important feature of the regional composition is the highest proportion of the category *Knowledge & Innovation* in Urban areas, and in particular in the NMS.

Figure 4: CAP payments intensities by category and regional typology:  
New member states



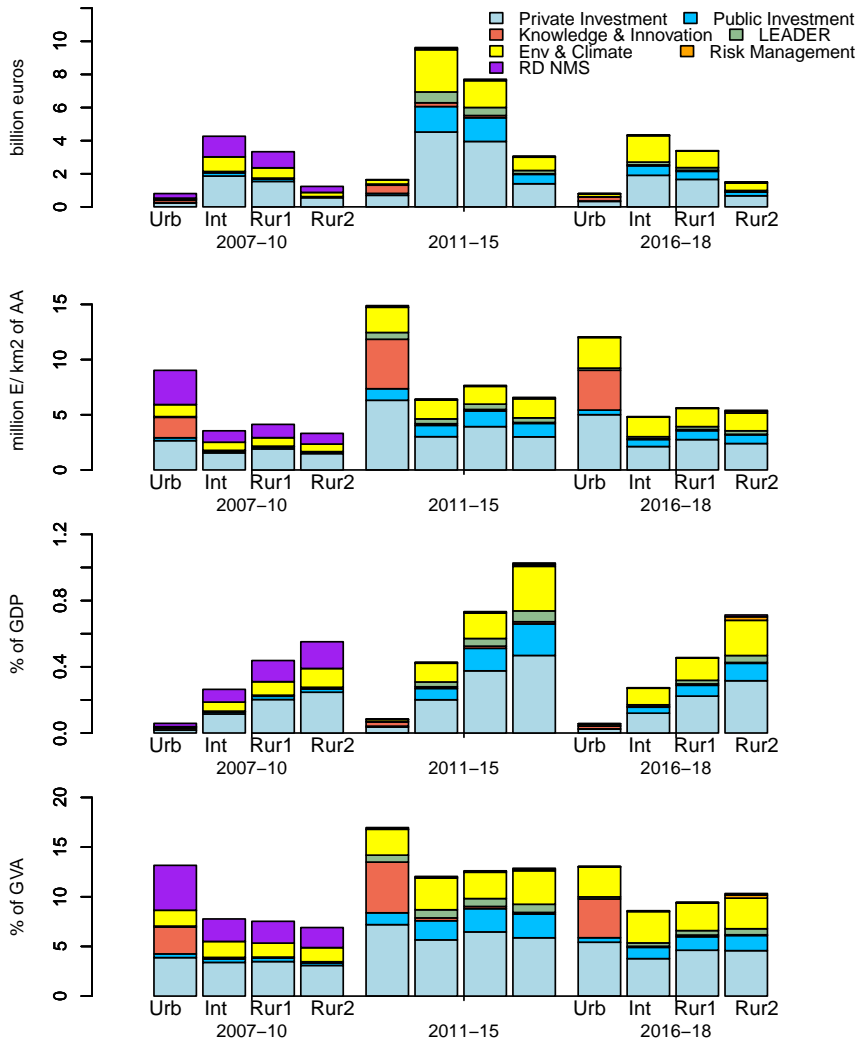
Note: Urb (Predominantly urban); Int (Intermediate); Rur1 (Rural close to city); Rur2 (Remote rural); RD Env (Rural Development Environment).

Figure 5: Pillar 2 intensities by category and regional typology:  
Old Member States



Note: Urb (Predominantly urban); Int (Intermediate); Rur1 (Rural close to city); Rur2 (Remote rural); Env (Environmental).

Figure 6: Pillar 2 intensities by category and regional typology:  
New Member States



Note: Urb (Predominantly urban); Int (Intermediate); Rur1 (Rural close to city); Rur2 (Remote rural); Env (Environmental); RD NMS (Rural Development New Member States).

### 3 The CAP policy mix dimension

The 2003 Fischler reform introduced two distinct funds for financing the CAP: the European Agricultural Guarantee Fund (EAGF) and the European Agricultural Fund for Rural Development (EAFRD). The EAGF (the first Pillar) finances direct payments to farmers and measures to respond to market disturbances, such as private or public storage and export refunds. The EAFRD (the second Pillar) finances the MS rural development programmes. Ever since that reform, the CAP put at the disposal of MS and EU regions diversified Pillar 1 measures and Pillar 2 instruments. This assortment of interventions suggests that the portfolio of policy choices made by MS, regions and farmers can be classified and its spatial distribution characterised.

This section analyses the implementation patterns of the CAP at the NUTS 3 level across the period 2007-2018. This characterisation results from a cluster analysis based on Principal Components on Pillar 1 and Pillar 2 measures with the following objectives:

1. First, to characterise the CAP mixes spatial distribution across the EU28. This exercise provides a unique description at the NUTS 3 level of the CAP implementation by identifying the set policy mixes across regions and across time. They are in some cases constrained by the MS options on the nature of the Direct Payments made available to farmers, the regions' economic characteristics and the type of measures and instruments made available by the CAP itself in each period.
2. Second, to investigate how their specific economic and geographical context can explain the CAP expenditure profile of the regions.
3. Third, the typology of the CAP expenditure generates a categorical treatment variable that assesses the overall impact of the policy in the different periods. This exercise explicitly provides a policy mix approach to the impact evaluation based on the effectiveness of both the distinct choices made by MS/regions and the instruments made available by the CAP throughout these periods.

CAP funds are measured as intensities to make them comparable across regions and identify their importance for the regional economy and the agricultural sector (primary beneficiary of Pillar 1 direct payments). For this purpose, Pillar 1 and Pillar 2 are measured relative to Gross Value Added (GVA) in agriculture in Purchasing Power Standards (PPS)<sup>7</sup> and total GVA in PPS.<sup>8</sup> The following sections describe the aggregation of Pillar 1 measures and Pillar 2 instruments and present a cluster analysis for the three periods.

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<sup>7</sup>Expressing GVA in PPS eliminates differences in price levels between countries.

<sup>8</sup>While Pillar 1 measures address the needs of the agricultural sector, the Rural Development Policies supported under Pillar 2 contribute to the overall regional economy.

### **3.1 Grouping Pillar 1 measures**

The 2003 reform and the 2009 Health Check decoupled most direct aid and introduced new payments schemes (Single farm payment). While still an important component of the CAP modernisation, decoupling in the 2013 reform is just a part of the new direct payments paradigm. The Pillar 1 strategy for the CAP 2014-2020 is the 'targeting' of direct payments by introducing a multifunctional support system coupled to specific objectives.

The diversity of direct payments schemes across these two periods and the existence of types of payments addressed to specific MS and regions suggest aggregating the Pillar 1 measures. As such, the direct payments in Pillar 1 were grouped in the three commonly used categories:

- **Market Measures under the Common Organisation of Markets (CMO):** This direct aid, applied to all agricultural products, constitute payments awarded to farmers in the event of a crisis that induce market disruptions. These may include market support measures in the event of outbreaks of animal diseases, or other events that lead to a loss of confidence by the public in agricultural products, and measures relating to concerted practices adopted when markets suffer serious imbalances.
- **Decoupled Direct Payments:** This classification includes all forms of direct payments awarded to farmers in advance detached from the production level. It ignores the specificity of the payments, regarding the nature of the beneficiaries (small farmers, young farmers, etc.) and the eligibility and implementation rules (area related, historical payments, new rules for the definition of entitlements etc.) and focus on their nature. It also includes the funds awarded under Pillar 2 to Least Favoured Areas.
- **Coupled Direct Payments:** These include all forms of direct payments linked to the production of specific products. This form of income has progressively been removed and replaced by decoupled payments. However, particular areas or types of farming with specific economic or social contexts still receive this type of support.

### **3.2 Grouping Pillar 2 measures**

The Pillar 2 instruments were grouped in either four categories - *Competitiveness, Public Investment, Agri-Environmental and LEADER* or in seven by disaggregating *Competitiveness* in four groups - *Productive investment, New Businesses, Knowledge & Innovation and Risk Management*.

The EAFRD (CAP's second pillar) supports the rural areas of the Union meeting the wide range of economic, environmental and societal challenges of the 21st century. A higher degree of flexibility (in comparison with the first pillar) enables regional, national and local authorities to formulate their individual seven-years rural development programmes based on a European



'menu' of rural development measures. Contrary to the first pillar, which the EU entirely finances, the second pillar programmes are co-financed by EU funds and regional or national funds.

In both the two programming periods considered in this report, Pillar 2 of the CAP is composed of a substantial number of measures that differ across many relevant dimensions. More specifically, different measures respond to one or more of the many general and specific objectives of the Rural Development policy. They target other sectors than the agricultural and forestry sector, such as tourism and the energy sector. Moreover, the beneficiaries of specific measures are private actors (e.g. farmers) or public institutions (local entities managing local development programs). Finally, the measures are implemented either with a 'bottom-up approach', i.e., similar to other regional EU funds including Cohesion Policy funds- through the reimbursement of expenses incurred by the beneficiaries for the realisation of the relative project, or through a 'top-bottom approach' more similar to the functioning of Pillar 1, i.e. support in the form of annual aid granted to beneficiaries with specific characteristics, or yet a combination of the two, namely a flat rate annual aid compensating specific investments and costs.

In order to reduce the number of CAP instruments under the Rural Development policy, it is helpful to identify groups of homogeneous measures across some relevant dimensions. This section presents the grouping of Pillar 2 measures adopted to characterise the CAP in the period 2007-2018.

### **Harmonising Pillar 2 across programming periods**

A significant challenge in categorising the Pillar 2 measures in the interval 2007-2018 arises from the fact that both the number and type of measures and their rationale changed considerably from the 2007-2013 programming period (Regulation (EC) No 1698/2005) to the next one (2014-2020, Regulation (EU) No 1303/2013).<sup>9</sup>

More specifically, the 2007-2013 rural development policy has three main objectives, namely: (a) improving the competitiveness of agriculture and forestry by supporting restructuring, development and innovation; (b) improving the environment and the countryside by supporting land management; (c) improving the quality of life in rural areas and encouraging diversification of economic activity.

The policy is implemented through 46 measures organised in four axes, each related to one of the objectives: Axis 1 is linked to competitiveness; Axis 2 covers environmental measures; Axis 3 is about rural development and; Axis 4 is a horizontal axis ('LEADER') for actions from Local Action Groups related to competitiveness, environment as well as rural development.

<sup>9</sup>EU Regulation 807/2014 of 11 March 2014 indicates the correlation between the measures of the two regulations, but there is no perfect one to one correspondence. Consequently, any grouping of measures applied to both programming periods would entail some degree of approximation.

Additional measures finance 'Technical Assistance' (the preparatory, monitoring, administrative support, evaluation and control measures) and complement direct payments only in NMS (in this case, Bulgaria and Romania, which entered the EU in 2007). M'barek et al. (2020) propose a grouping of Pillar 2 measures following the three-axis rationale, but considering two dimensions of competitiveness: Human Capital and Physical Capital.<sup>10</sup>

In the following programming period, Pillar 2 is based on similar fundamental general objectives. More specifically, the three overarching priorities established by the Commission for the 2014-2020 rural development policy are: (1) fostering agricultural competitiveness; (2) ensuring sustainable management of natural resources and climate action; (3) achieving balanced territorial development of rural economies and communities, including the creation and maintenance of employment<sup>11</sup>.

These objectives are achieved through 20 measures. However, a single measure can address more than one of those main objectives simultaneously, and allocating precisely each measure to each priority is not feasible. For example, Measure 4, 'Investment in physical assets', addresses the objective of increased competitiveness of the agricultural sector by providing support for investments in agricultural holdings and in infrastructures related to development, modernisation or adaptation of agriculture and forestry, as well as environmental objectives by providing support for non-productive investments linked to the achievement of Agri-environment-climate objectives.<sup>12</sup>

## **A production function approach**

This section proposes a grouping of Pillar 2 measures that apply to both programming periods. The classification takes a "production function" approach in which the different measures are considered inputs for the production of rural development.

Four broad categories of inputs are considered: *Competitiveness*, *Public Investment*, *LEADER*, and *Agri-environmental*. More specifically, within the category of measures contributing to increasing the *Competitiveness* of agricultural and forestry sector, the following groups are considered:

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<sup>10</sup>The authors consider five groups of measures: Investments in human capital; Investments in physical capital; Wider Rural Development Schemes; Support to Least Favoured Areas; Agri-environmental measures.

<sup>11</sup>Those main objectives translate into the following six EU priorities for rural development policy: (i) Fostering knowledge transfer in agriculture, forestry and rural areas; (ii) Enhancing the competitiveness of all types of agriculture and enhancing farm viability; (iii) Promoting food chain organisation and risk management in agriculture; (iv) Restoring, preserving and enhancing ecosystems dependent on agriculture and forestry; (v) Promoting resource efficiency and supporting the shift toward a low-carbon and climate-resilient economy in the agriculture, food and forestry sectors; (vi) Promoting social inclusion, poverty reduction and economic development in rural areas. Source: Regulation (EU) No 1303/2013.

<sup>12</sup>Similar examples are: Measure 6 'Farm and business development', which contributes both to improving the competitiveness of the agricultural sector through start-up aid for young and small farmers, and to the development of rural areas providing support for investments in creation and development of non-agricultural activities; Measure 8 'Investments in forest area development and improvement of the viability of forests' aims at improving the environment but also finances investments in forestry technologies and processing, mobilising and marketing of forest products to improve the competitiveness of the forestry sector.

- *Productive Investment* includes all measures funding productive investments in existing activities that increase the capital productivity and promote: modernisation of agricultural holdings, infrastructure related to the development and adaptation of the agricultural and forestry, improvement of the economic value of forests, etc..<sup>13</sup>
- *New Businesses* groups all measures promoting the development of new activities or the generational renewal of existing activities: start-up of brand new activities (e.g. setting up of young farmers, and for the same rationale the early retirement scheme), as well as diversification in non-agricultural activities and restructuring of existing activities (e.g. restructuring of semi-subsistence agricultural holdings in the NMS). These measures promote both the diversification of the economic activities and the modernisation of the agricultural sector footnoteWithin this group of measures, it is not possible to distinguish investments in agricultural activities from non-agricultural activities.
- *Knowledge & Innovation* includes all measures that contribute to the regions' human capital in general and in particular of farmers: measures financing knowledge transfer and information, technical assistance, advisory service, schemes for agricultural products and foodstuffs, as well as supporting producer groups for information and promotion activities.
- *Risk Management* covers the risk management measures introduced in the 2014-2020 programming period together with measures financing prevention and restoration actions in both programming periods. These measures promote a new paradigm in the farming business by encouraging farmers to anticipate risks and develop strategies to increase their resilience to adverse situations.

The remaining Pillar 2 categories are:

- *Agri-environment*: This includes all measures addressing the general objective of improving the environment that goes beyond the "relevant mandatory standards" (cross-compliance and greening): the so-called Agri-Environmental Climate Measures (AECM), e.g. agri-environment-climate payments, organic farming and payments for adapted farming practices on areas falling under the scope of the Natura 2000 Directive and Water Framework Directive, forestry environmental measures, etc.
- *Public Investment*: An additional group includes measures aimed at achieving the general objective of the development of rural areas, whose beneficiaries are mainly public actors (local entities and institutions). These could be investments in infrastructures that benefit businesses and populations, village renewal and preservation of cultural heritage that create the conditions for the flourishing of economic activities

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<sup>13</sup>In the 2014-2020 programming period, these measures are classified as *Investments in physical assets*, but they include non-productive activities linked to the achievement of agri-environmental and climate objectives.

- *LEADER*: Finally, a separate group includes measures under the LEADER approach, i.e. a ‘bottom-up’ approach in which different actors (farmers, rural businesses, local organisations, public authorities and individuals from distinct sectors) form local action groups (LAGs) that manage local development strategies.

The detailed list and composition of the groups is presented in A.

### **3.3 The mixed Pillar 1 and Pillar 2 clusters**

This section characterises the spatial distribution of CAP clusters in period 2007-2018. It shows how the CAP as a policy mix evolved in the EU28 territory and how its spatial distribution changed across the reform-based time intervals.

The clusters are based on a Principal Components Analysis (PCA) applied to Pillar 1 and Pillar 2 funds. Although often applied to reduce the dimensionality of multivariate analysis, in this particular context, the PCA is used as a pattern recognition technique, i.e., it provides a way of recognising patterns and regularities in the data. In this context, the Principal Components’ patterns correspond to groups of NUTS 3 regions with similar CAP funds implementation choices.

The clustering exercise is replicated in each of the three periods, 2007-10, 2011-15 and 2016-18, to reflect how the CAP implementation models of the EU NUTS 3 regions adapted to the CAP reforms. However, although the three analyses are period specific and not directly comparable, an attempt is made to identify clusters with similar characteristics across periods.

Table 1 shows the CAP mix clusters in the three-time reform-based intervals. For each cluster, the Table shows an index of the average amount of funds in the cluster relative to the period average (first row) and relative to the average across the three periods (second row). The level of the index is linked to a set of colours: a palette of green colours represent high values (with strong green showing the maximum) and a palette of red colours represent low values (red for the minimum level of the index). Therefore, the Table illustrates each fund’s relative importance within each period and across the three periods. The last row of the Table compares the funds’ composition across time by computing the ratio of the average funds in the period to the total average. The Table groups the clusters with similar characteristics and ranks them according to the intensity and degree of specialisation on Pillar 1 (lowest rank) and Pillar 2 (highest rank) within each period (first row).

The Table highlights the differences in the clusters/typologies across periods. It reflects the regions’ choices and the CAP reforms promoted in each period. In addition, the relative lower intake of all Pillar 2 measures in 2016-18 reflects the ongoing nature of the last Programming Period and consequently of the MS’s rural development plans implementation.

Table 1: Heat table of CAP mix clusters composition by period

CAP mix clusters		2007-2010										2011-2015										2016-2018									
		Pillar 1					Pillar 2					Pillar 1					Pillar 2					Pillar 1					Pillar 2				
		CMO	Coup	DP	Decoup	COM PET	LEA DER	Pub Inv	Agri Env	CMO	Coup	DP	Decoup	COM PET	LEA DER	Pub Inv	Agri Env	CMO	Coup	DP	Decoup	COM PET	LEA DER	Pub Inv	Agri Env						
Low Pillar 2	Very Low Pillar 1																														
	Strong CMO	2	173	37	58	13	9	8	14	2	626	69	76	73	68	22	43	2	144	27	51	17	15	10	16						
	Strong Decoupled	1	60	103	116	31	53	26	66	1	68	98	82	20	7	7	39	1	62	93	123	38	42	23	53						
	Strong DP																														
	Very Strong DP	3	60	411	250	48	88	24	101	3	68	392	176	30	12	7	60	3	108	335	250	63	55	22	76						
Strong DP and Pillar 2	Very Strong DP																														
	Strong DP	4	59	200	166	233	756	160	571	4	67	191	117	147	105	43	339	4	73	135	105	261	265	190	252						
	Very Strong Pillar 2																														
Strong P2 Low P1	Low Pillar 1	5	53	35	67	148	143	171	143	5	61	33	47	94	20	47	85	5	48	79	92	181	174	180	180						
	Very Strong Pillar 2	6	37	3	55	644	112	736	178	6	42	2	39	407	16	200	106	6	80	87	77	463	402	620	383						
			114	95	70	63	14	27	59		116	101	132	145	196	187	132		69	104	97	91	88	84	108						

Note: Agri Env (Agri-environmental); CMO (Common Market Organization/Market Measures); COMPET (Competitiveness); Coup (Coupled); Decoup (Decoupled); DP (Direct Payments); Pub Inv (Public Investment); P2 (Pillar 2).  
 Table entries: ratio of average funds intensity in the cluster to average funds intensity in the period (first row) and to average intensity in both periods (second row).  
 Last row: average funds intensity in the period sample to average funds intensity in both periods.

Each period is characterised by six clusters but only two are common to the three periods: Cluster 2 represents regions with a very low intake of Pillar 2 and simultaneously strong on Market Measures. Cluster 5 groups regions with strong Pillar 2 and below-average Pillar 1 funds.

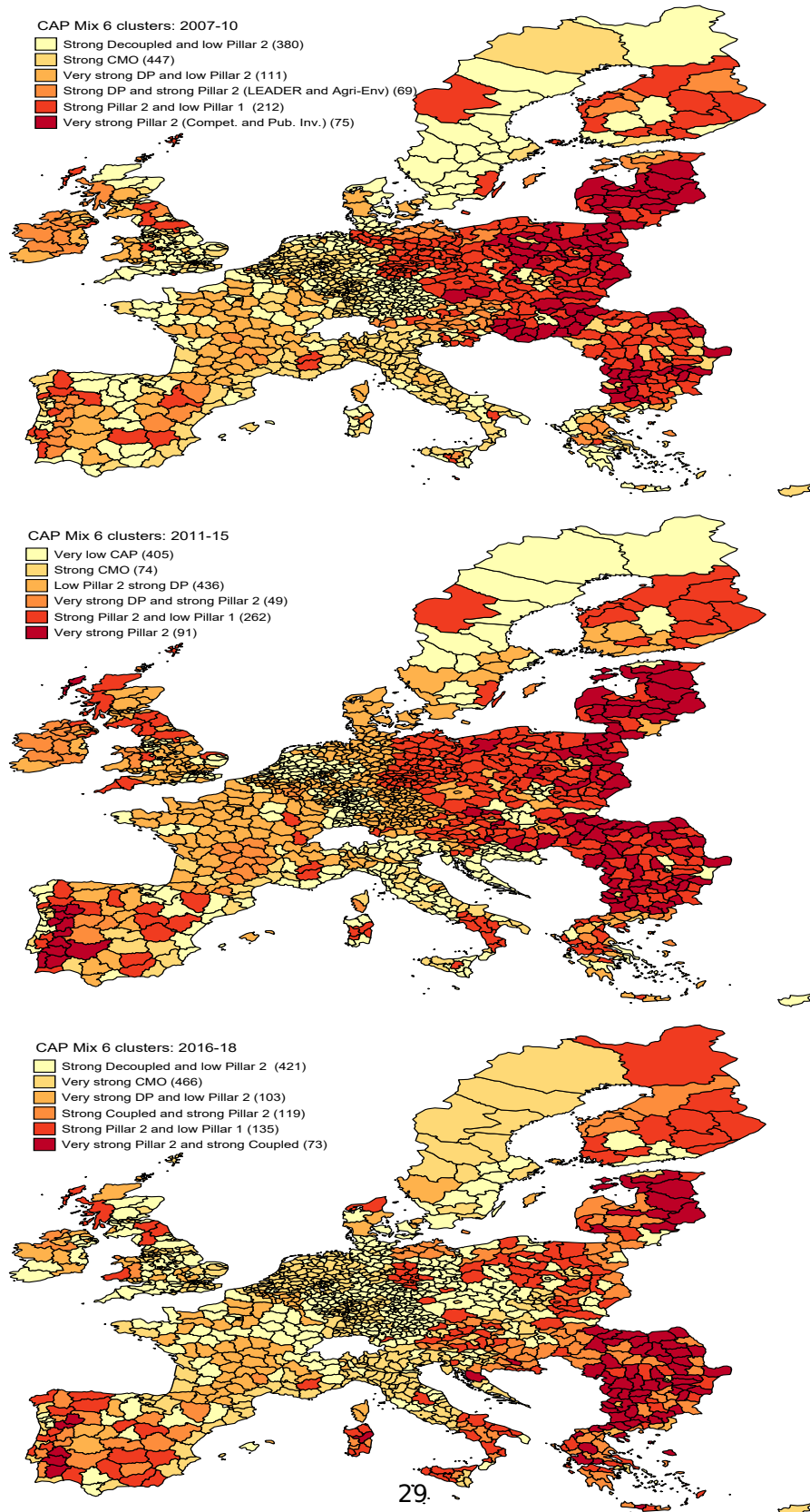
The clustering exercise identifies ten clusters classified in three groups: (1) Low on Pillar 2 interventions; (2) Strong on Pillar 2 and Direct Payments and; (3) specialised on Pillar 2, i.e., strong on Pillar 2 and simultaneously low on Pillar 1. The first group exhibits similar characteristics in the first and last periods: in both, there isn't a cluster with very low intake of all CAP measures, as in the second period and some regions with low Pillar 2 are also characterised by the maximum average value of both forms of Direct Payments. This contrasts with the second period, where the cluster with this characteristic is also very strong on all Pillar 2 measures except *Public Investment*.

Another essential feature of the CAP mix evolution is how the clusters with very strong Pillar 2 interventions differ significantly across the three periods. In 2007-10, there are two clusters with maximum average values of Pillar 2 measures: the first with very strong average *LEADER* and *Agri-Environmental* is associated with regions with strong intake of Direct Payments and the second with a strong profile on *Competitiveness* and *Public Investment* has the minimum average value of all Pillar 1 measures. In the second and third periods, the Pillar 2 interventions with maximum average are concentrated in a single cluster. However, in 2011-15 this cluster is more specialised as it is associated with a below-average Pillar 1 intake.

Figure 7 shows the spatial distribution of the clusters. The colors are scaled as to represent a subjective ranking, ranging from lower average Pillar 2 and average Coupled and strong Decoupled in the first and last period, and very low CAP in the second, to very strong Pillar 2 (and very low Pillar 1 in the first period).

- In the first period, the colors' intensity clearly distinguishes between the CAP implementation models of OMS and NMS. While in the first group, most regions are in clusters strong on Pillar 1 measures, in the second the clusters strong on Pillar 2 dominate. The exceptions in the first group are mainly regions in PT, ES, IE where strong Direct Payments coexist with a strong investments on *LEADER* and *Agri-Environmental* Pillar 2 instruments. A distinct feature of this period is the relative strong importance of Market Measures in most OMS regions.
- In the second period, despite being characterised by the *Health-check reform*, the color's intensity mainly reflect an increase in the Pillar 2 expenditure. In addition to the NMS and southern regions of the OMS where the CAP clusters with a very strong Pillar 2 profile persist, some regions in FR and IE traditionally very strong on Direct Payments, are now more Pillar 2 oriented. Conversely, regions in the NMS and in southern OMS that were strong on Pillar 2 only witness now an increase in Direct Payments. A distinct feature of

Figure 7: Spatial distribution of CAP mix clusters by period



this period that contrasts with both the Pillar 2 increase and the Direct Payments extension to the NMS, is the existence of large number of regions in central, northern Europe IT, and coastal regions in FR and ES that have a very low intake of CAP funds.

- In the third period, the 'Pillar 2 revolution' is now accompanied by an increase of Pillar 1, and in particular Decoupled payments in NMS traditionally strong on Pillar 2 investments. These regions are mainly situated in PL. This is a consequence of the *external convergence* between the two groups of countries. In addition Market Measures reassume again an important role in many distinct EU regions where the CAP intake was previously low. An important feature of this period is that the NMS and southern OMS where the Pillar 2 measures were very strong, now belong to a cluster where in addition there is a average strong intake of Coupled payments.

This characterisation shows the evolution of the CAP across time. It shows the impact of the Pillar 2 revolution, Decoupling, external convergence and the relevance of Market Measures.

The overall policy mix approach analysis provides a characterisation of the regional implementation of the CAP based on the intensities of both Pillar 1 and Pillar 2 groups of measures. A separate analysis for each Pillar may be required if interest lies in specific features of the CAP policy or/and if the policy mix characterisation is to be achieved by considering the two pillars separately.

### 3.4 The Pillar 1 clusters

In this exercise the input variables for the cluster analysis are the three groups of Pillar 1 measures: *Market Measures*, *Coupled Direct Payments* and *Decoupled Direct Payments*.<sup>14</sup>

Table 2 shows the clusters and summarises with heat map visualisations the index of the average of each variable in the clusters relative to the total average in the respective period (first row) and to the average across the three periods (second row). Each period is characterised by six clusters ranked according to the instruments' intensity. The (subjective) ranking assumes that the individual instruments can be ordered from, *Market Measure* (lowest rank) to *Decoupled Direct Payments* (highest rank).

The ranking shows how the extremes of the clusters' distribution have changed overtime. In the first period, the lowest ranked cluster has an (almost) average intensity of *Market Measures* and the highest ranked cluster is specialised on *Decoupled Direct Payments*. In contrast, in the last period there is a cluster with low intensity in all CAP instruments, but the highest ranked cluster exhibits an high intensity of all Pillar 1 measures.

<sup>14</sup>The Kaiser-Meyer-Olkin (KMO) test of sampling adequacy is below 0.5 which implies that the variables under consideration do not share much variance and the PCA is unsuitable. Therefore, the methodology in this section skips the extraction of the PCs and applies directly the Ward hierarchical cluster analysis on the Pillar 1 variables.



Table 2: Heat table of Pillar 1 clusters composition by period

Pillar 1 clusters		2007-2010			2011-2015			2016-2018						
		CMO	Coup	DP	Decoup	CMO	Coup	DP	Decoup	CMO	Coup	DP	Decoup	
Low DP	Low CMO	1			1			1			82	75	59	57
	Average CMO	92	33	33	95	22	24	95	22	32	110	22	32	
	Average DP	105	32	23	110	22	32	110	22	32	110	22	32	
	Strong Decoupled	2			2			2			81	96	107	56
	Strong Decoupled	78	44	150	65	94	98	65	94	98	75	95	129	81
	Strong Decoupled	89	42	106	75	95	129	75	95	129	75	95	129	56
V. strong CMO	Low DP	3			3			3			180	27	22	125
	Strong Coupled	132	128	93	173	60	63	173	60	63	201	60	82	125
	Strong Coupled	151	122	66	201	60	82	201	60	82	201	60	82	125
Very strong strong DP	Very Strong Coupled strong Decoupled	4			4			4			85	220	199	59
	Very strong Decoupled strong Coupled	53	298	229	70	214	183	70	214	183	81	217	241	59
	Very Strong Decoupled	61	285	161	81	217	241	81	217	241	81	217	241	59
	Very Strong Decoupled	63	82	636	133	130	747	133	130	747	133	130	747	137
	Very Strong Decoupled	72	78	448	155	131	982	155	131	982	155	131	982	95
	Very Strong Decoupled	114	95	70	116	101	132	116	101	132	116	101	132	69
	Very Strong Decoupled	114	95	70	116	101	132	116	101	132	116	101	132	69

Note: CMO (Common Market Organization/Market Measures); Coup (Coupled); Decoup (Decoupled); DP (Direct Payments).  
 Table entries: ratio of average funds intensity in the cluster to average funds intensity in the period (first row) and to average intensity in both periods (second row). Last row: average funds intensity in the period sample to average funds intensity in both periods.

Overall the Pillar 1 clusters are more similar in the last two periods and only Cluster 5 is common across time. This cluster covers the *Coupled Direct Payments* with the highest intensity together with strong intake of *Decoupled DP*.

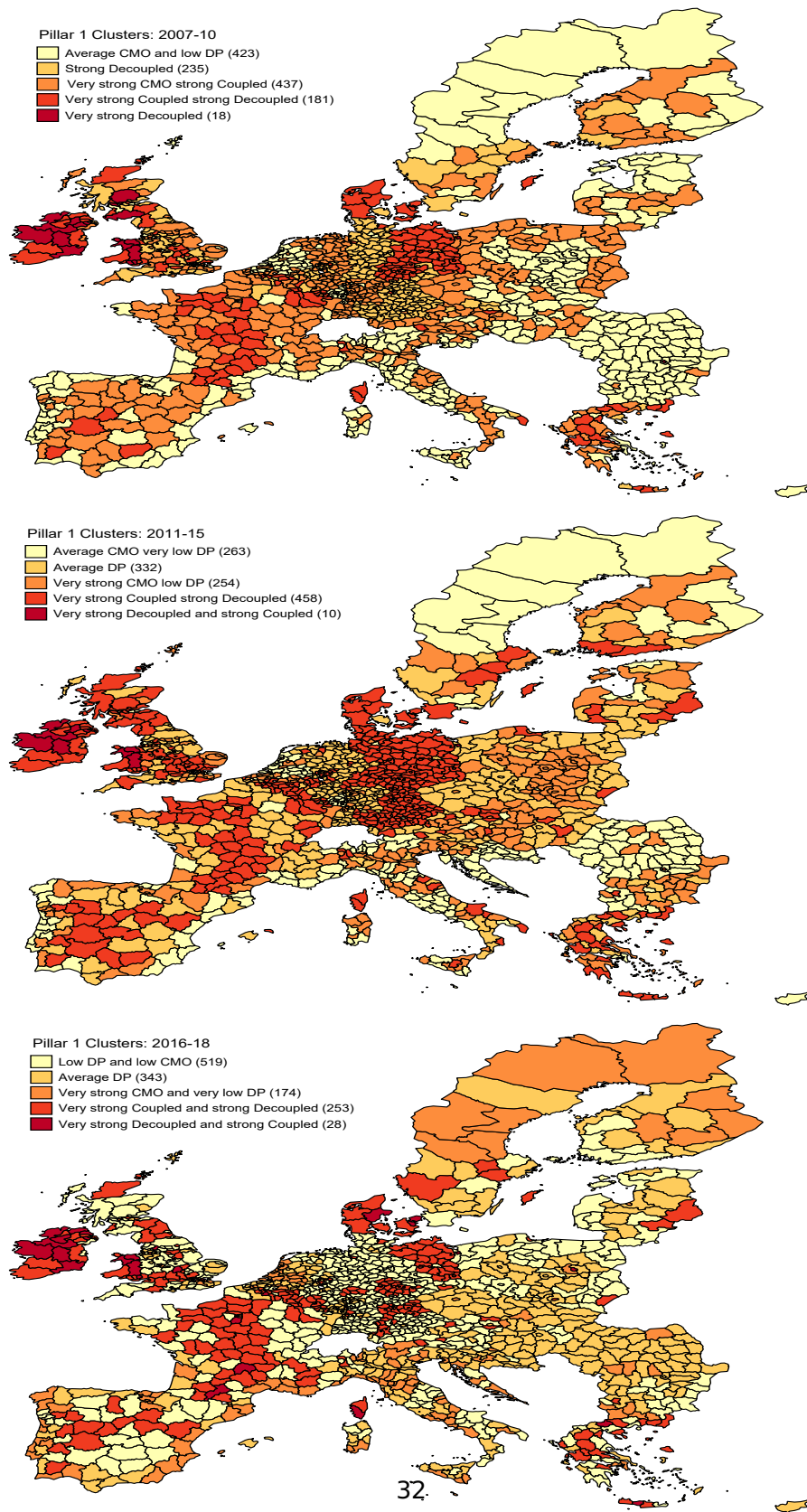
There are two features that distinguish the first period from the rest: First, the very strong *Market Measure* cluster (cluster 3) is also strong on *Coupled DP* while in the subsequent period it is specialised, i.e., the other inputs have a low or very low intensity. Secondly, the clusters strong and very strong *Decoupled DP* (cluster 5) are specialised in the first period while in the second the intensity of the other inputs is above the overall average.

An interesting feature of the last two periods is the presence of a cluster with a very strong intensity of *Decoupled DP* and simultaneously a strong intake of the other Pillar 1 instruments.

Figure 8 shows the spatial distribution of the Pillar 1 clusters across time. Again the colours in the maps reflect the (subjective) ranking, where the clusters specialised on *Decoupled Direct Payments* (represented with darker colours) have the highest rank.

- The colours in the first period show the difference in Pillar 1 implementation between OMS and NMS. A large proportion of NMS regions is occupied by the low-intensity *Direct Payment* cluster. This cluster, also characterised by an average intake of *Market Measures* appears in parts of northern Europe, Italy and coastal areas of Spain, southern France and Portugal. The remaining regions in NMS are characterised mainly by the *Very Strong CMO* and *strong Coupled*. These two clusters, composed of the 'traditional' forms of CAP support, represent most EU28 territory. The remaining regions are in clusters with a strong intensity of *Decoupled Direct Payments*: The cluster where also *Very strong*

Figure 8: Spatial distribution of Pillar 1 clusters by period



*Coupled Direct Payments* are present, takes the highest share, found mainly in central regions of France, Germany, Spain Portugal, Greece and UK; the *Strong Decoupled* in some areas of Germany and; the cluster with the higher intensity of *Decoupled Direct Payments* in parts of the UK.

- The colours of the map in the second period reflect the beginning of the external convergence process. The proportion of NMS regions with very low *Direct Payments* intensity reduced significantly and can only be found in Romania. The remaining areas are now in the *Very strong CMO and low DP*. On the other, NMS regions that were previously in this last cluster are now receivers of *Average Direct Payments*. This is the case of Poland and the Baltic countries. The cluster distribution in the OMS also changed significantly in this period. First, the presence of *Very strong CMO* cluster has diminished in most regions of France, Portugal, in Spain. In fact, this cluster no longer occupies the majority of the EU28. In these countries, it has been replaced by *Average Direct Payments* and *Very strong coupled and strong decoupled* which is now the prevalent cluster.
- In the third interval, the external convergence process of the CAP is visible in the map. While the NMS regions are mainly part of the *Average Direct Payments* cluster, the *Low Pillar 1* cluster is primarily present in OMS regions previously benefiting from an *Average DP*. In fact, this cluster occupies a significant part of Germany, France, Spain and the UK. Another essential feature of this period is the reduction of regions receiving CAP support in the form *Very strong CMO*. These can now be found in coastal areas of Spain, Portugal and France, some regions in Italy and, in the northern European countries with previously *Average CMO and low DP* intensity.

Overall, the cluster analysis on Pillar 1 instruments illustrates how the NMS have moved from an implementation model based on *Market Measures* to one with an average intensity of *Direct Payments*. Furthermore, the analysis shows that despite the emphasis on decoupling, the clusters based on high intensity of *Coupled Direct Payments* still occupy a significant part of the EU territory and, in particular, of the OMS.

### **3.5 The Pillar 2 Clusters**

The Pillar 2 clusters are based on the grouping of instruments with the highest level of disaggregation. The PCA considers six groups: *Private Investment, New Businesses, Knowledge & Innovation, LEADER, Public Investment* and *Agri-Environmental* while the characterisation of the clusters adds the *Risk Management* group.<sup>15</sup>

<sup>15</sup>This category is not used as it has very few observations in the earlier periods.

Table 3 shows the composition of the clusters in the three periods. Again these are ranked from *Very Low* to *Very Strong* intensity.<sup>16</sup>

The analysis identifies five clusters in each period whose characterisation changes significantly through time. The same occurs to the overall average intake of rural development measures. Apart from the categories *Knowledge & Innovation* in the first period and *Risk Management* in the third period, the highest average amount of Pillar 2 instruments occurs in the second period.<sup>17</sup>

From the eleven clusters, only one, characterised by a very low intake of Pillar 2 measures (except for *Risk Management* in the first period), is common across the three periods. The remaining ten clusters are grouped in three categories: *Selected*, *Strong* and *Very strong Pillar 2* interventions.

The group characterised as *Selected* identifies regions with investments above average in just a few Pillar 2 interventions: *Risk Management*, *LEADER* and *Agri-Environmental* in the first period; *Knowledge & Innovation* in the second; and *Knowledge & Innovation* and *Agri-Environmental* in the third.<sup>18</sup>

The *Strong* Pillar 2 cluster again has a different composition in the three periods. In the first period, it is composed of two clusters: one again strong on *LEADER* and *Agri-Environmental* and average on *Public Investment* and *Private Investment* and; the other strong on all but *LEADER* (and *Risk Management*). There is only one cluster with a homogeneous distribution of Pillar 2 measures intensities in the second period. At the same time, the third is composed of two clusters with the same composition but different intensities. If *Risk Management* is not taken into account, these are strong in all interventions except for *Knowledge & Innovation*.

Finally, the *Very strong* category presents two different profiles across time. In the first and last period, these clusters have a very high intensity in all Pillar 2 sub-groups except for *Risk Management*. In contrast, in the second period, this group is composed of two clusters: the first has a very strong intake of *LEADER*, *Agri-Environmental* and *Knowledge & Innovation* and the second on the remaining measures.

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<sup>16</sup>Ranking the clusters with different compositions is a subjective task as it requires an evaluation of qualitatively different instruments.

<sup>17</sup>This may reflect on the one hand the increase of Pillar 2 expenditure relative to the first period and the ongoing spending under the 2014-2020 Programming Period yet not converted in payments.

<sup>18</sup>Although not relevant within the second period, when compared with the three period average, *LEADER* and *Agri-Environmental* instruments are interventions with average intake above average.

Table 3: Heat table of Pillar 2 clusters composition by period

Pillar 2 clusters	2007-2010							2011-2015							2016-2018							
	Priv Inv	New Busin	K&I	Risk Manag	LEA DER	Pub Inv	Agri Env	Priv Inv	New Busin	K&I	Risk Manag	LEA DER	Pub Inv	Agri Env	Priv Inv	New Busin	K&I	Risk Manag	LEA DER	Pub Inv	Agri Env	
Very Low Pillar 2	1	24	19	8	128	15	23	25	14	8	20	25	15	8	16	12	7	19	46	13	6	17
		13	10	13	6	2	6	15	21	13	17	16	29	15	21	11	7	8	106	11	5	19
Selected High K&I	2	59	44	15	126	124	77	147	64	41	110	55	79	29	86	71	48	180	70	74	41	93
		32	24	26	6	17	21	87	97	63	97	36	154	55	114	66	45	78	160	65	34	100
Strong LEADER and Agri-Env	2	59	44	15	126	124	77	147	64	41	110	55	79	29	86	71	48	180	70	74	41	93
		32	24	26	6	17	21	87	97	63	97	36	154	55	114	66	45	78	160	65	34	100
LEADER/ Agri-Env Avge Pub/ Priv Invest	3	95	78	33	50	370	103	257	95	78	33	50	370	103	257	95	78	33	50	370	103	257
		52	41	56	2	51	28	152	52	41	56	2	51	28	152	52	41	56	2	51	28	152
Strong but LEADER	4	278	245	280	0	63	317	100	278	245	280	0	63	317	100	278	245	280	0	63	317	100
		152	130	475	0	9	86	59	152	130	475	0	9	86	59	152	130	475	0	9	86	59
Strong Pillar 2	3	144	134	161	274	168	132	161	144	134	161	274	168	132	161	144	134	161	274	168	132	161
		219	206	142	178	330	248	214	219	206	142	178	330	248	214	219	206	142	178	330	248	214
Strong but K&I	4	318	246	325	53	342	182	355	318	246	325	53	342	182	355	318	246	325	53	342	182	355
		485	377	288	35	670	341	470	485	377	288	35	670	341	470	485	377	288	35	670	341	470
K&I, LEADER and Agri-Env	4	431	562	273	282	336	629	321	431	562	273	282	336	629	321	431	562	273	282	336	629	321
		656	863	242	183	657	1179	425	656	863	242	183	657	1179	425	656	863	242	183	657	1179	425
Priv and Pub Invest and New Businesses	5	474	560	664	0	457	419	391	474	560	664	0	457	419	391	474	560	664	0	457	419	391
		260	297	1126	0	63	114	232	260	297	1126	0	63	114	232	260	297	1126	0	63	114	232
Very strong Pillar 2	5	474	560	664	0	457	419	391	474	560	664	0	457	419	391	474	560	664	0	457	419	391
		260	297	1126	0	63	114	232	260	297	1126	0	63	114	232	260	297	1126	0	63	114	232
Average		55	53	169	5	14	27	59	152	154	89	65	196	187	132	92	93	43	228	89	84	108

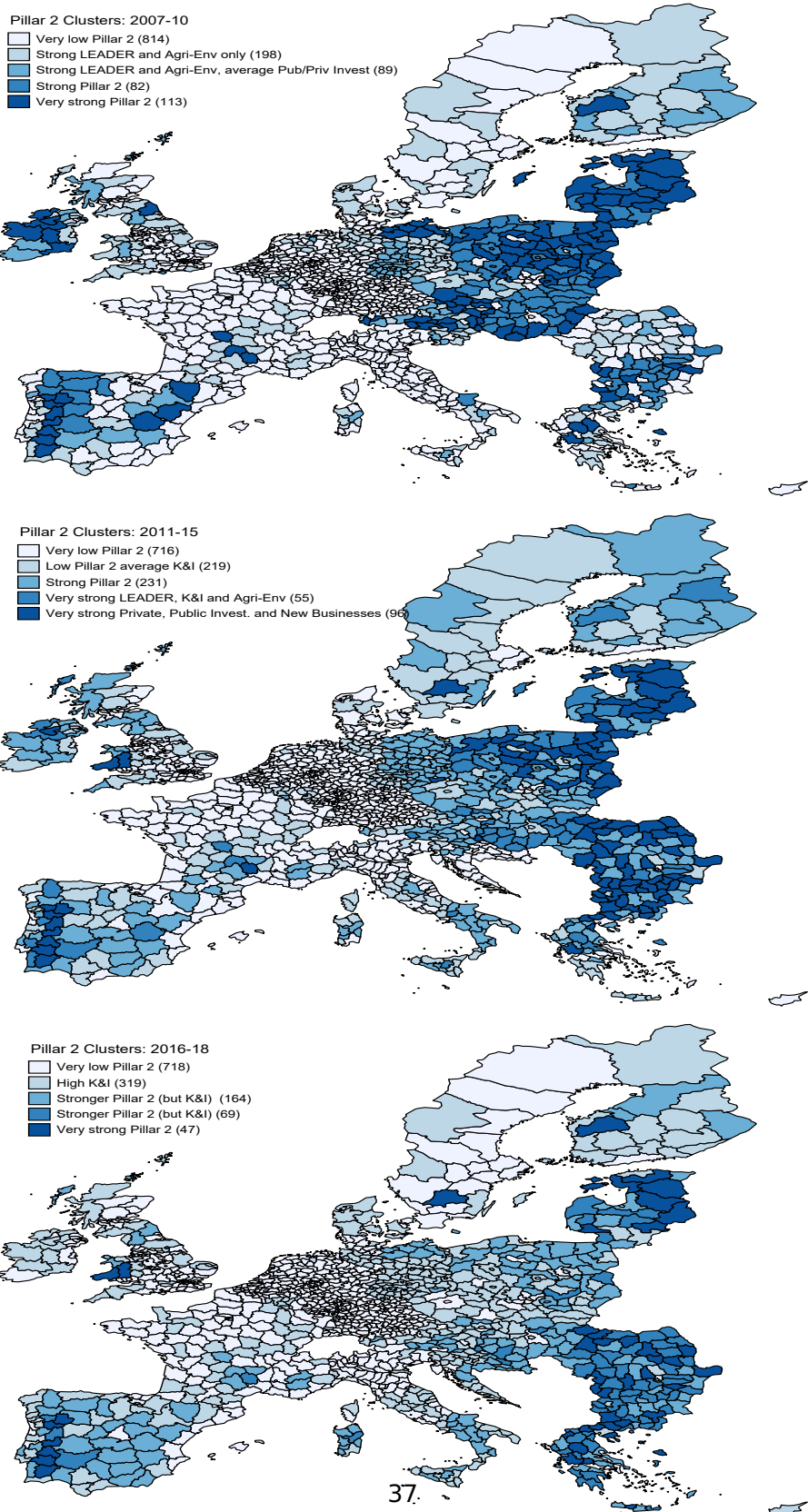
Note: Agri Env (Agri-environmental); K&I (Knowledge & Innovation); New Busin (New Businesses); Avge Pub Inv(est) (Average Public Investment); Avge Priv Inv(est) (Average Private Investment); P2 (Pillar 2); Risk Manag (Risk Management).  
 Table entries: ratio of average funds intensity in the cluster to average funds intensity in the period (first row) and to average intensity in both periods (second row). Last row: average funds intensity in the period sample to average funds intensity in both periods.

Figure 9 shows the Pillar 2 clusters across the three periods. Again, more intense colours correspond to regions with relatively higher intensity of Pillar 2 payments within each period, although the same colours may represent different intensities across periods. In all periods, the central parts of the EU are always relatively low intakes of Pillar 2 measures. At the same time, the NMS, southern countries (PT, ES, HR) and some regions in the UK (IE) are the largest beneficiaries of rural development instruments.

- The clusters distribution in the first period reflects this trend. The exceptions are some regions in north RO and some central regions of FR. The cluster strong on *LEADER* and *Agri-Environmental* measures occupy the largest proportion of the EU area and can be found mostly in OMS (FR, DE, UK, SE and FI);
- The second period maintains this dichotomy between NMS and southern regions of the EU and OMS (particularly central Europe). However, within the NMS, two very strong Pillar 2 profiles coexist, while some regions originally low on Pillar 2, in the OMS (central and northern EU) show some investment on *Knowledge & Innovation*.
- In the third period, the clusters' distribution reflects the reduced share of Pillar 2 expenditure due to the incompleteness of the Programming Period. Some regions in the NMS (PL) are now in less Pillar 2 intensive clusters and simultaneously exhibit a Pillar 2 profile more similar to some regions of the OMS.

The clustering exercise identifies a group of regions in the central EU that are not beneficiaries of RD funds. The composition of the Pillar 2 measures in the EU28 has changed in the three periods. In the first period, the clusters with higher intensity reveal regions with two different RD strategies: one stronger on *LEADER* and *Agri-Environmental* and another very strong on all other measures. In the subsequent periods, the clusters are more associated with different intensity levels, except for the *Public Investment* component. The analysis suggests that this later cluster has overtime become a more sought RD strategy.

Figure 9: Spatial distribution of the Pillar 2 clusters by period



## **4 The EU rural dimension**

### **4.1 Review of the Literature**

This section reviews rurality typologies that have been developed in the literature. Given the 'nature' of typology proposed in this study, the focus is on typologies that are based on multidimensional approaches using a wide set of socio-economic indicators.<sup>19</sup> In what follows, this section classifies the various contributions based on the coverage of countries. There are studies that develop typologies for a single or some countries and others applied to EU12 and EU28 Member States. One study covers the OECD countries using data at NUTS 2/3 level.

#### **Typologies that focus on one or some countries**

Cloke (1977) develops an index of rurality for England and Wales applying principal component analysis to a set of discriminating variables (in year 1971) such as population density, percentage of males working in the area employed in primary rural industries, percentage of the resident occupied population working in another local authority area.

The study of Cloke and Edwards (1986) replicates the above study using data for 1981 and compare the new index of rurality with the old version at the district scale illustrating spatial changes in the rurality classifications.

Barjak (2001) uses cluster analysis to construct a typology of regions for East Germany and Poland on the basis of indicators for economic capabilities and their determinants. The study shows that capable regions are linked to largest agglomerations, high income, low unemployment and large stocks of qualified labour contributing to technical progress.

Auber et al. (2006) apply principal component analysis to define rural areas in France. Merlo et al. (1992) and Anania and Tenuta (2008) focus on Italian rural areas. Balestrieri (2014)'s work presents the results of a multivariate analysis applied on two sets of rurality/urbanity and competitiveness indicators for the municipalities in the region of Sardinia, Italy.

Buesa et al. (2006) develop a typology of the Spanish R&D system using factorial analysis on the Regional Production and Innovation Environment, the University, the Public Administration and Private Enterprises. They find that the Spanish regions that stand out are Madrid (Public Administration), Catalonia (Environment), Basque Country (Private Enterprises) and Navarra (University). The authors also show (using regression analysis) that the Regional Production and Innovation Environment is more important factor compared to the other three for the regions' innovative capacity.

Relying on data from the 2001 Population Census, Lowe and Ward (2007) apply a factor analysis to more than 100 socio-economic variables (including various population, commuting,

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<sup>19</sup>For a thorough review see Copus et al. (2008)



demographic and deprivation indicators) to define rural areas in UK. The authors identify the following seven countryside types: 'dynamic commuter areas', concentrated in the South East of England; 'settled commuter areas' mostly associated with city regions; 'dynamic rural areas' associated with universities/research centres; 'deep rural areas' with high tourism activity; 'retirement retreat areas' with high shares of ageing populations; 'peripheral amenity areas' located on the coast with high tourism and retirement related activities; 'transient rural areas' located close to urban centres with low income and high commuting levels.

### **Typologies that focus on EU Member States**

Terluin et al. (1995) investigate the agricultural income situation in the less favoured areas of EU12 in the years 1987–1988, 1988–1989 and 1989–1990 based on an agricultural typology developed using the relationship between the regional gross domestic product per inhabitant and farm net value added per annual work unit. Based on the three classifications 'Northwest', 'Central' and 'South', the authors show that in 'Northwest' and 'Central' the income gap is larger than in the 'South' and that the level of farm income in 'Northwest' and 'Central' is considerably above that in 'South'.

The analysis of Ballas et al. (2003) builds a typology for rural areas in EU by applying both principal component and cluster analysis on data for NUTS 3 regions. The authors argue that the proposed typology depicts well the various national differences especially for smaller Member States such as Greece and Portugal and they signal that the proposed classifications should only be used as approximations of reality and as guidelines into more thorough analysis.

An analysis focused on the agricultural sector is provided by Vidal et al. (2001) that characterises its spatial components in EU rural areas. Using NUTS 3 level data from Eurostat (except for Germany, Belgium and the Netherlands where data is related to NUTS 2 regions) the authors' classification stems from a Principal Component Analysis followed by a hierarchical (k-mean) classification of a large set of variables covering various thematic fields such as demography, economic strength, agricultural employment, farm labour force, agricultural land use, farm structure and livestock. The proposed classification illustrates the high diversity of EU rural areas and important spatial differences between EU regions.

The approach of the ESPON 2013 project EDORA (Copus et al., 2011) acknowledges both macro and micro-scale dimensions of variation in developing the following three aspects of rural differentiation: (i) 'Rurality and Accessibility', which relates to the 'intermediate accessible', 'intermediate remote', 'predominantly rural accessible', and 'predominantly rural remote' classifications developed by DG Regio (Dijkstra and Poelman, 2008); (ii) 'Economic Restructuring' which relates to both the Agri-Centric and Global Competition classifications and distinguishes the non-urban EU regions in 'agrarian', 'consumption countryside', 'diversified' (strong secondary sector), and 'diversified' (strong market services sector); (iii) 'Performance' which is

a typology that places EU regions on a continuum between 'accumulation' and 'depletion', and derives its rationale mainly from the DG Regio's Rural-Urban classifications. This typology distinguishes the regions to the following categories: 'accumulating', 'above average', 'below average', and 'depleting'.

Raggi et al. (2013) proposes a multidimensional classification of 1303 NUTS3 regions, reflecting the heterogeneity of NUTS3 characteristics in the EU based on four criteria: rural character, accessibility, actual economic diversification, and total Gross Domestic Product per capita. The classification aims to facilitate the comparison of rural development policy impacts between regions of interest across Europe. Three different approaches are discussed: traditional cluster analysis, latent class models and multiple cluster structures.

The Esposti et al. (2013) analysis proposes a new composite and comprehensive measure of rurality and peripherality based on NUTS3 level data. Using a Principal Component Analysis approach the authors develop the 'PeripheRurality' indicator (PRI) that takes into account both conventional socio-economic variables and relevant geographical dimensions of the regions. Furthermore, by adopting a hierarchical cluster analysis, the study analyzes the link between the RDP expenditure intensity in the regional clusters and the PRI using simple correlation coefficients.

The work of Pagliacci (2017) provides a multidimensional and continuous indicator of rurality by means of fuzzy logic. The proposed continuous fuzzy rurality indicator takes into account the EU28 NUTS 3 regions and covers thematic areas such as share of agricultural activities and agricultural areas, demographic dimensions and territorial characteristics (landscape and use of land). The author argues that the indicator returns an insightful picture of EU urban-rural areas and compared to the OECD-Eurostat's classifications is more accurate in characterizing the rurality level of the EU regions. Methodologically, the fuzzy rurality indicator is superior compared to OECD-Eurostat urban-rural typologies because it has all the properties of continuous indicators.

### **Typology that focuses on OECD countries**

Bollman et al. (2005) use the regional typology of the OECD to examine differences in employment growth between predominantly rural, intermediate rural and predominantly urban regions in the 1990s for 14 OECD countries. Furthermore, they analyze whether regions maintain a relatively high or low rate of employment growth over the 1980s and 1990s. For this, they rank regions in each country according to their employment growth in the 1980s in a top 1/3 group, a middle 1/3 group and a bottom 1/3 group. Then, they compare the position of regions in the 1980s with that in the 1990s. They find that employment growth in the leading predominantly rural and intermediate rural regions in the 1990s tended to exceed that in predominantly urban regions, which is a continuous pattern stemming from the 1980s.

Rurality is a vague concept. There is no precise definition of the term rurality and no consensus among researchers about how to measure it.

The existing measures developed by the EC (Dijkstra and Poelman (2010)) and the OECD (Programme et al. (1994, 1996, 2006)) are based on distinctions between predominantly urban (PU), intermediate (IR) and predominantly rural (PR) regions using only a single indicator, i.e., demographic density. This 'categorical typology' results to classifications where dissimilar regions are classified in the same group. For this reason the applied literature has developed many rurality typologies.

## 4.2 The rurality clusters

This section develops a measure of rurality that is tailored to the analysis of the spatial distribution of the CAP. It considers various dimensions of the nature of EU NUTS 3 regions' rurality: structural, socio-economic, territorial/geographical, agricultural. In this way, rurality becomes a spatial measure/concept that allows studying its link with e.g. the differences of CAP expenditures' intensity and structure across EU NUTS 3 regions. The typology proposed can be used as an evaluation policy tool addressing research questions such as: "How does the different levels of CAP expenditures relate to the nature and degree of rurality of the EU NUTS 3 regions?"

The analysis departs from the Eurostat's urban - rural typology where the EU NUTS 3 regions are classified as predominantly urban, intermediate and predominantly rural, and following Camaioni et al. (2013) adopts a multidimensional approach to define and classify the degree and nature of rurality. The proposed classification uses the following set of indicators classified in six thematic areas:

*Local economy indicators:* The share (in total) of agricultural gross value added (GVA) and the share of GVA of the industry sector (except construction) in million PPS. The GDP per capita captures the development level of the region.

*Agricultural sector indicators:* The analysis adopts labour productivity of agriculture (i.e. the ratio of agricultural GVA in million PPS over total employment in agriculture) and land productivity of agriculture (i.e. the ratio of agricultural GVA in million PPS over total agricultural area). In addition, the indicator of 'agricultural employment density' is considered, i.e., total number of people employed in agriculture per square kilometer of agricultural area.

*Demographics indicators:* Population density (persons per square kilometer), crude birth rate (the ratio of the number of live births during the year to the average population in that year), and crude rate of net migration plus statistical adjustment (i.e., the ratio of net migration - including statistical adjustment - during the year to the average population in that year). The net migration plus adjustment is calculated as the difference between the total change and the natural change of the population.

*Innovation indicators:* To capture the knowledge and innovation capacity of the regions the analysis uses the number of European Union trade mark (EUTM) applications and the number of Registered Community designs (RCD).

*Land use and landscape indicators:* Three land cover indicators namely, the share of forest area, share of land covered by artificial areas and share of agricultural areas.

*Remoteness and geographical indicators:* The methodology includes indicators on the distance of NUTS 3 regions from major urban areas and in particular, the concept of MEGA (Metropolitan Economic Growth Area) from ESPON.<sup>20</sup> The development of MEGAs –which are basically the strongest functional urban areas (FUAs) in Europe– is based on indicators for *mass* (population size and size of the economy), *competitiveness* (GDP per capita and location of head offices for the top 500 European companies), *connectivity* (number of airport passengers and the regions' multimodal accessibility), *knowledge basis* (people with high education, people working with R&D).

Including the population density variable in the exercise leads to the isolation of urban regions and this leads to a distorting output of the analysis because these regions have additional characteristics that become 'silent' for the other regions in the sample once they 'show up' in the bundle of urban regions' characteristics. For this reason, the group of predominantly urban NUTS 3 regions are excluded from the PCA and hierarchical cluster analysis.

Regarding the time coverage of the indicators included in the analysis, this study focuses on the beginning of the sub-periods defined by the *Reform Based Approach* (see Section 2) i.e. 2007, 2010 and 2015. Most of the adopted indicators are structural and they are not influenced by fluctuations due to economic shocks, hence it is reasonable to assume that the proposed typology remains intact within the three sub-sample periods (2007-2010, 2011-2015 and 2016-2018).

## **A multidimensional approach**

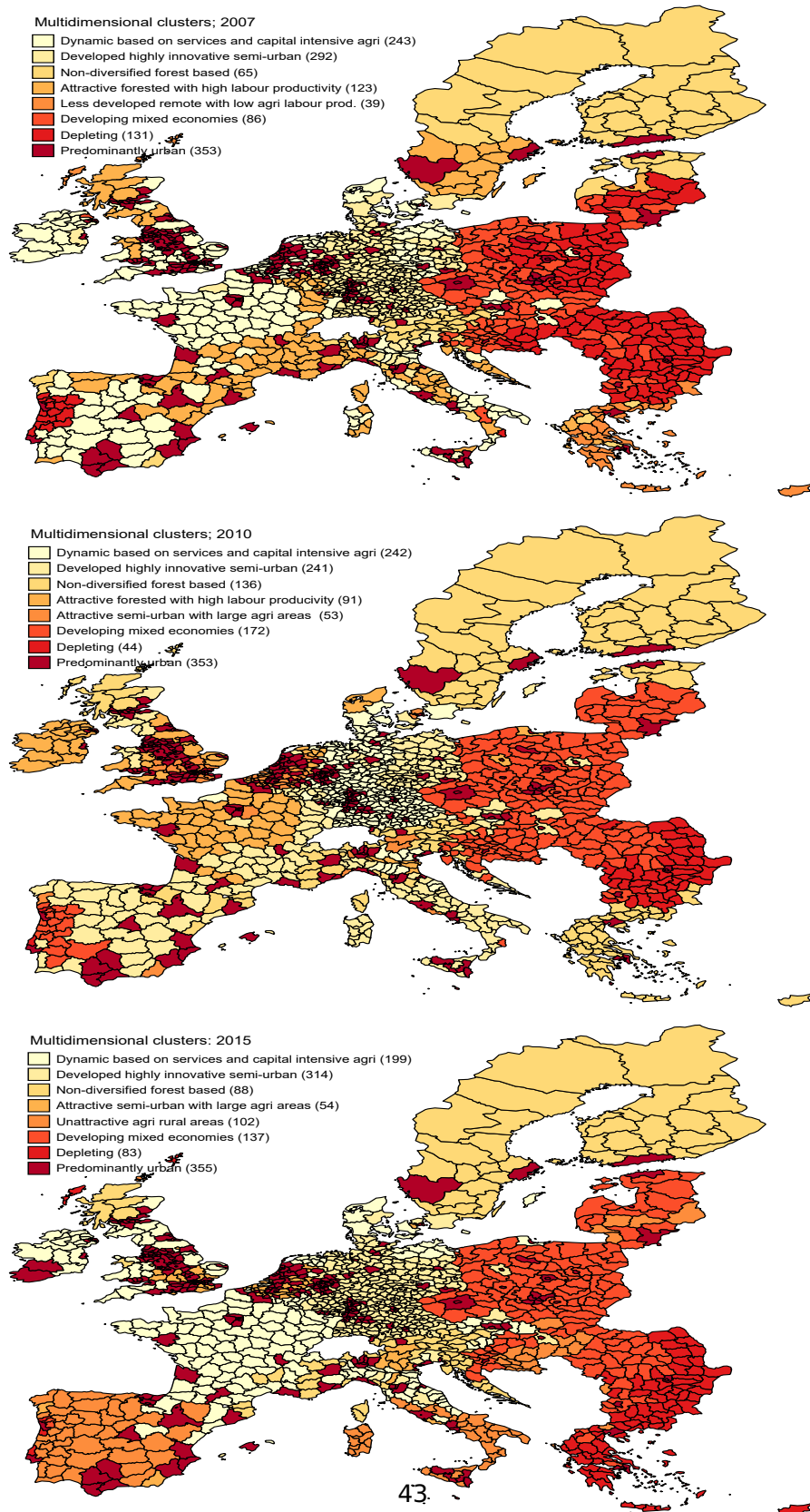
The multidimensional approach for developing the CC-ME typology for NUTS 3 regions' degree and nature of rurality is structured as follows. First, the study applies a Principal Component Analysis (PCA) to the 18 indicators described above.<sup>21</sup> After the extraction of the Principal Components, the standardised scores for the EU NUTS 3 regions in the sample are computed and finally these scores are clustered with a Ward hierarchical cluster analysis.<sup>22</sup> The final output of these two approaches is shown in Figure 10 for the years 2007, 2010 and 2015. The 8 classifications of the CC-ME typology cover various dimensions and stress different characteristics of the EU NUTS 3 regions in years 2007, 2010, and 2015.

<sup>20</sup>See ESPON 111, Potentials for polycentric development in Europe. [https://www.espon.eu/sites/default/files/attachments/fr-1.1.1\\_revised-full\\_0.pdf](https://www.espon.eu/sites/default/files/attachments/fr-1.1.1_revised-full_0.pdf)

<sup>21</sup>For methodological details on the PCA see Annex B.

<sup>22</sup>For details on the PCA see Annex B.

Figure 10: Spatial distribution of the Multidimensional rurality clusters by period



The following typologies are defined, based on the centers of the principal components (PCs) which were extracted applying the Ward hierarchical cluster analysis and following the Guttman-Kaiser criterion (i.e., keeping the PCs that explain 70-80% of the cumulative variance):

*Typology 1:* Dynamic regions based on services and capital intensive agricultural sector;

*Typology 2:* Developed highly innovative semi-urban regions;

*Typology 3:* Non-diversified forest based regions;

*Typology 4 (2007, 2010):* Attractive forested regions with high labour productivity;

*Typology 4 (2015):* Attractive semi-urban regions with large agricultural areas;

*Typology 5 (2007):* Less developed remote regions with low agricultural labour productivity;

*Typology 5 (2010):* Attractive semi-urban regions with large agricultural areas;

*Typology 5 (2015):* Unattractive agricultural rural areas;

*Typology 6:* Developing regions with mixed economies;

*Typology 7:* Depleting regions;

*Typology 8:* Predominantly urban regions

Table 4 summarises with heat map visualisations the average values of the variables that have been included in the PCA and characterise the CC-ME typologies across the three sub-periods (the palette of colors ranges from deep red denoting low values to deep green for high values).

Typology 1 covers the NUTS 3 regions with high population density and birth rate, low share of GVA in both industry and agriculture, and low employment in agriculture. These regions are close to cities, have large agricultural areas and not so many forests. Furthermore, they are probably services-based economies with their agricultural sector generating high value with relatively less agricultural employment. The set of NUTS 3 regions included in this typology are mainly from the old member states (OMS) and there are only a few regions in the new member states (NMS) e.g. in Hungary, Slovakia, Lithuania and Poland.

Typology 2 is linked to high GDP per capita and low share of GVA of agriculture. They are highly populated regions which are close to MEGA1 cities and have very good performance in both indicators of innovation (EUTM and RCD). The share of industry in total economy is relatively high and the artificial areas are relatively large. The agricultural sector in these regions is small. In 2007, this typology characterises mainly NUTS 3 regions in Germany and Italy.

In 2010, there are also many regions in Spain, France, Austria and Belgium classified as developed and highly innovative urban, whereas in 2015 the number of NUTS 3 regions in this typology drops to 88 covering mostly regions in Germany, Austria and Italy.

Table 4: Heat table of Multidimensional clusters: 2007, 2010 and 2015

	Multidimensional clusters	Local Economy		Agri-Sector			Demographics			Innovation		Land Use			Remoteness				
		GVA share Agri	Ind	GDPpc (PPS)	GVA Agri per Empl	per AA	Empl per AA	Pop dens	Birth rate	Net migr	EU TM	CD	Forest	Artif	Agri	Mega1	Mega2	Mega3	Mega4
2007	Dynamic regions based on services and capital intensive agricultural sector	99	80	107	137	109	60	114	107	196	40	20	56	126	128	93	95	69	96
2010		88	88	110	166	88	38	92	114	225	74	69	39	97	145	107	62	71	98
2015		72	90	112	143	86	44	94	105	179	78	70	72	98	122	80	68	56	108
2007	Developed highly innovative semi-urban regions	39	118	121	109	85	55	165	87	24	277	299	92	124	105	36	92	70	127
2010		29	124	153	124	98	50	220	91	198	662	774	79	152	113	32	78	50	134
2015		28	116	147	104	80	56	209	97	913	540	639	89	151	106	31	93	53	130
2007	Non-diversified forest based regions	100	112	120	112	189	131	36	103	81	26	25	194	53	33	119	74	204	85
2010		102	89	115	100	127	112	45	100	257	65	67	167	53	49	147	62	194	132
2015		62	97	126	104	127	97	44	103	270	63	62	187	53	32	84	84	143	103
2007	Attractive forested regions with high labour productivity	71	75	109	114	90	63	52	107	404	29	21	145	65	71	94	75	74	116
2010		83	77	105	115	87	58	89	95	276	74	52	107	81	99	70	106	62	123
2015		48	78	135	142	203	97	306	107	420	178	136	40	283	126	46	76	37	103
2007	Less developed remote regions with low agricultural labour productivity	189	52	90	62	131	171	34	106	190	9	1	137	45	77	325	57	304	170
2010		47	78	133	147	198	86	298	109	478	135	98	40	290	125	45	75	38	102
2015		153	77	83	97	97	91	64	84	-227	45	16	104	53	105	91	158	89	112
2007	Developing regions with mixed economies	119	139	67	59	82	121	56	105	-51	8	11	113	81	95	98	130	87	48
2010		124	131	68	50	74	132	74	98	-288	27	34	103	84	102	95	148	82	54
2015		109	144	71	56	71	129	77	104	-162	42	62	102	93	101	108	137	96	53
2007	Depleting regions	225	102	46	30	83	260	54	103	-111	7	6	92	84	108	187	157	145	52
2010		226	127	44	21	74	295	65	96	-354	15	5	75	99	119	212	140	210	60
2015		202	88	62	43	100	225	55	95	-135	33	22	112	73	93	239	96	246	122
2007	Predominatly Urban	20	81	148	92	536	637	1032	117	163	135	71	54	592	76	88	75	65	103
2010		17	84	158	93	476	612	1437	112	324	333	220	52	639	78	71	74	59	114
2015		16	82	159	91	429	644	1469	116	493	347	203	52	633	77	71	73	59	114

Notes: GDPpc (PPS) (GDP per capita in PPS); GVA Agri per Empl (GVA of agricultural sector by employment in agriculture); GVA Agri per AA (GVA of agricultural sector by agricultural area); Empl per AA (Employment in agricultural sector by agricultural area); GVA share Agri (Share of GVA of agriculture); GVA share of Ind (Share of GVA of industry); Pop dens (Population density); Net migr (Net migration); EU TM (EU Trademark); CD (Community Design); Forest (Forest area percentage); Artif (Artificial area percentage); Agri (Agricultural area percentage); Mega1 (Distance to Mega 1 city); Mega2 (Distance to Mega 2 city); Mega3 (Distance to Mega 3 city); Mega4 (Distance to Mega 4 city).

Table entries: ratio of average value of input variable in the cluster to variable average value in the sample by period.

Typology 3 is linked to large forest areas and low share of artificial and agricultural areas. The typology includes regions with non-innovative (traditional, non-sophisticated) industrial sectors in Southern and Western Austria, Estonia, Greece, Spain, Finland, Croatia, Italy, Sweden and Slovenia.

The NUTS 3 regions in typology 4 are attractive regions (i.e. with high positive net migration levels) with large forest areas and average agricultural areas in the typologies developed for years 2007 and 2010, whereas for 2015 this classification changes to *attractive semi-urban regions with large agricultural areas* covering again regions with high positive net migration but very small forests, large artificial and agricultural areas. The economies of typology 4 are not agricultural neither industrial and probably they are based on other economic activities. Many regions in South France, Central Italy, North UK and Sweden belong to the category *Attractive forest based regions with high labour productivity*. The respective taxonomy in 2015 covers mainly Belgian, Italian and UK regions.

Typology 5 varies across the three years of the exercise. In year 2007 it includes the *less developed remote regions with low agricultural labour productivity* which is mainly Greece, three UK regions, one region in Cyprus and one in Bulgaria where the labour productivity of agriculture is low. These regional economies are based on agriculture (no industry).

Typology 5 in 2010 classifies the EU regions with very high positive net migration and large artificial and agricultural areas close to MEGA 3 cities. These economies are relatively developed and they are based on a robust agricultural sector and probably also on services (no industry). Regions in Belgium, Netherlands, UK and Italy appear in this classification.

For the year 2015 the label of typology 5 is *unattractive agricultural rural areas* because it covers regions with very high negative net migration, high share of agricultural GVA and low industry. The productivity of the agricultural sector is below the average and the distance from MEGA 2 cities is high. This classification is mainly represented by regions in Spain, Italy and Portugal.

Typology 6 covers many NUTS 3 regions of the NMS (since 2004). The GDP per capita in these regional economies is very low and the production relies both on agricultural and industrial sectors, however their GVA is low.

The label of typology 7 is 'Depleting regions' because the strongest characteristic/variable that comes up with very high average negative value is *Net migration rate*. Shrinking regions in EU seem to be concentrated in the NMS and specifically in Bulgaria, Romania. However, in 2015, most of the Greek regions also had very high negative net migration rates and are included in this classification. This is most probably due to the severe impact that the 2008 economic crisis had on the Greek economy.

Finally, typology 8 covers the *predominantly urban regions* as defined in the OECD extended regional typology (Brezzi et al., 2011).



## **An agricultural based approach**

Given that the CC-ME typology above has been developed as a tool for evaluating the CAP, this section develops it further focusing on the agricultural characteristics of the NUTS 3 economies. Therefore, it replicates the above analysis considering as input variables the *Agricultural sector indicators* and the *Land use and landscape indicators*. The analysis also takes into account the NUTS 3 regions' share of GVA of agriculture. As above, the Ward hierarchical cluster analysis is directly applied on the extracted PCs of the agricultural variables.

Figure 11 show the 6 typologies classifying the EU NUTS 3 regions using only agricultural indicators and Table 5 provides again heat map visualisations of the average values of the variables that have been included in the analysis and characterise the agri-sector clusters across the three sub-periods.

Cluster 1 labeled *High labour productivity with forest* includes regions with relatively small agricultural sector and average extent of agricultural areas. The 'agricultural employment density' is low, however the productivity of labour is high. Regions in South France, Spain, Germany, Italy, Belgium and Germany are included in this classification. There are also some regions in Czech Republic, UK, Austria, Slovakia and Greece with these characteristics.

Cluster 2 covers the NUTS 3 regions with relatively important agricultural sector with many employees that produce low GVA. These regions are also characterised by relatively large forest areas. In 2007 are mostly concentrated in Romania, Portugal, Poland, Greece, Bulgaria, Croatia, Slovenia and Latvia. In 2010, this typology has a different geography and covers mainly regions in Finland, Sweden and Austria. There are also some regions in Italy, France, Spain, Slovenia and Greece. In 2015, this typology encompasses the *low labour productivity and labour intensive agriculture* regions with higher share of GVA of agriculture and forest areas at the average level. Then in this year the number of regions belonging to this typology increases to 381 including regions from almost all EU countries.

Cluster 3 is mainly forest areas with very productive use of small agricultural lands. Artificial areas are also very small and the share of GVA of agriculture is below the total average.

Cluster 4 puts together the NUTS 3 regions with traditional and large agricultural sectors that exhibit low (labour and land) productivity. In 2007 and 2010 these regions are concentrated mainly in the Eastern European Countries and Greece. In 2015 however, the regions with these characteristics are distributed more uniformly across Europe. Figure 11 depicts many regions in Finland, Austria and Sweden. There are also regions in Greece, Bulgaria, Spain, France, Hungary, Italy, Latvia, Portugal, Romania, Slovenia and UK.

Cluster 5 includes the highly productive agricultural regions (both in terms of labour and land). These regions are the relatively more urbanised and industrialised areas of the EU. Regions in North France, Belgium, Italy, Netherlands, Germany and UK belong to this category.

Finally, as above, cluster 6 covers the *predominantly urban* regions as defined in the OECD

Figure 11: Spatial distribution of Agri-sector based rurality clusters by period

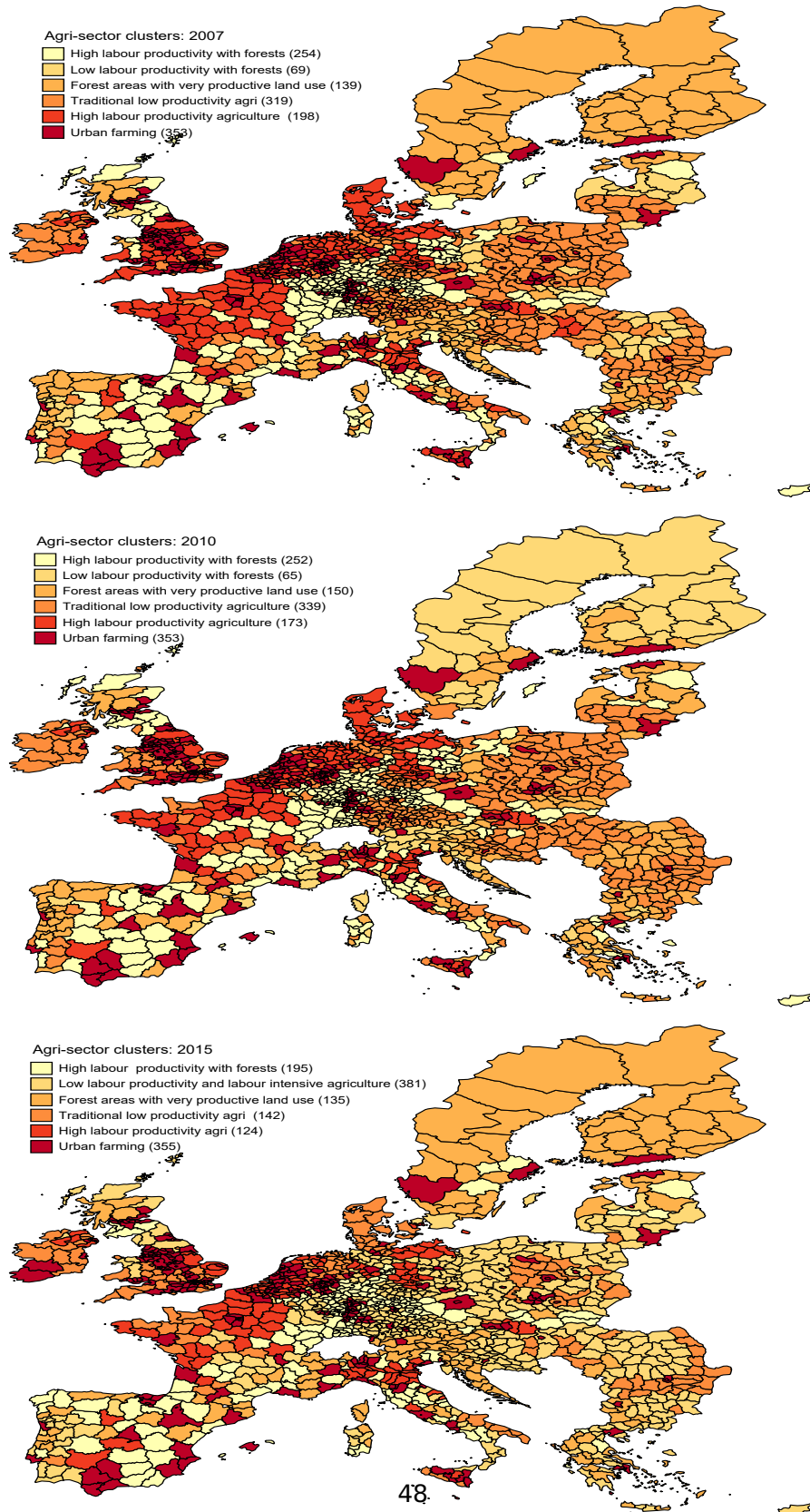


Table 5: Heat table of Agri-sector based clusters composition: 2007, 2010 and 2015

Agri-sector based clusters		GVA Agri per Empl Agri	GVA Agri per AA	Emp Agri per AA	GVA share Agri	Forest (%)	Artificial (%)	Agriculture (%)
2007	High labour productivity with forest	131	93	52	88	115	95	89
2010		123	89	55	87	112	94	92
2015		144	112	54	92	124	84	86
2007	Low labour productivity with forest	35	83	206	119	138	80	76
2010		63	95	154	103	153	68	65
2015		61	77	131	111	101	98	100
2007	Forest areas with very productive land use	104	137	111	86	183	50	40
2010		128	175	111	83	204	42	23
2015		96	123	104	88	163	50	40
2007	Traditional low productivity agricultural sector	55	71	125	127	69	105	123
2010		58	72	116	121	64	104	127
2015		69	74	114	117	33	113	149
2007	High labour productivity agriculture	164	121	49	76	34	154	145
2010		187	133	48	78	35	170	142
2015		192	141	52	76	36	177	141
2007	Urban farming	95	496	538	16	52	643	78
2010		93	476	612	17	52	639	78
2015		91	429	644	16	52	633	77

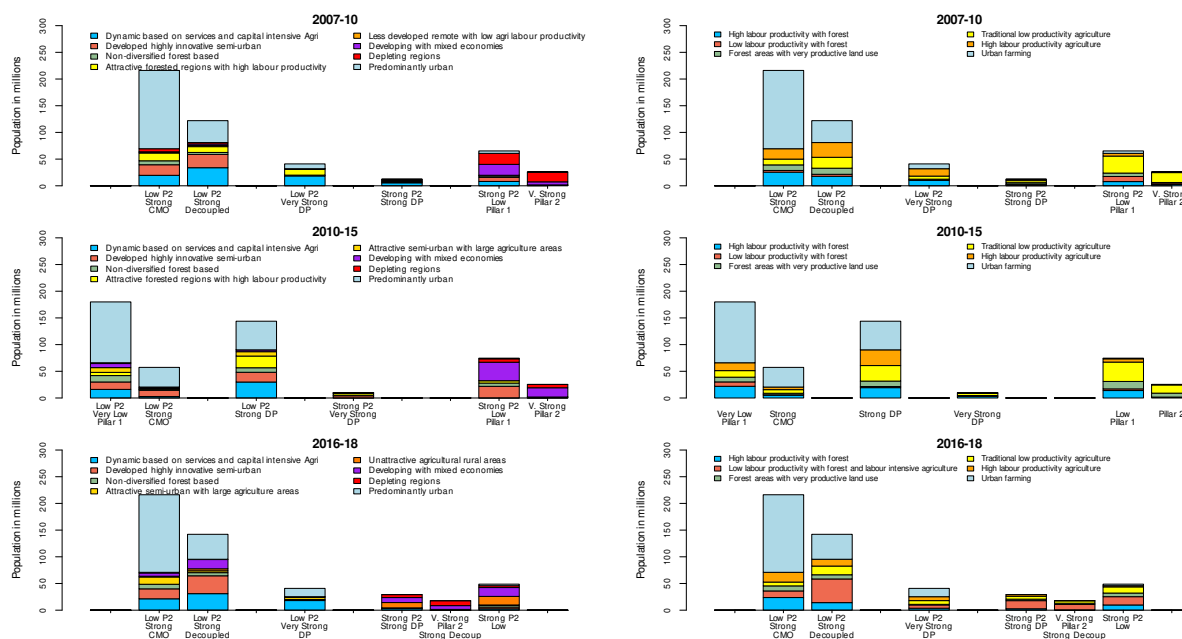
Notes: GVA Agri per Empl (GVA of agricultural sector by employment in agriculture); GVA Agri per AA (GVA of agricultural sector by agricultural area); Emp Agri per AA (Employment in agricultural sector by agricultural area); GVA share Agri (Share of GVA of agriculture); Forest (%) (Forest area percentage); Artificial (%) (Artificial area percentage); Agriculture (%) (Agricultural area percentage).  
Table entries: ratio of average value of input variable in the cluster to variable average value in the sample by period.

extended regional typology. For this exercise, given that the proposed typology focuses on the agricultural sector, the label 'urban farming' i.e. production of agricultural goods in cities, municipalities or heavily populated towns, seems more appropriate. As expected, the cluster is characterised by high productivity of land and high 'agricultural employment density'.

## 5 The regional dimension of the CAP

This section examines how the distribution of the CAP mix relates to the rurality typologies. By investigating the rurality composition of the CAP clusters, the analysis provides insight into the regional dimension of the CAP implementation. It is important to investigate if the different CAP mixes tend to be implemented in specific rural regions.

Figure 12: Multidimensional (left panel) and Agri-sector based (right panel) rurality clusters composition (in population) of CAP mix clusters by period



Note: CMO (Common Organisation of Markets/Markets Measures); DP (Direct Payments); Decou (Decoupled Direct Payments); P2 (Pillar 2); V. Strong (Very Strong).

The relationship between rurality type and CAP mix is measured by the benefited population in each rurality cluster across the CAP mix clusters.<sup>23</sup>

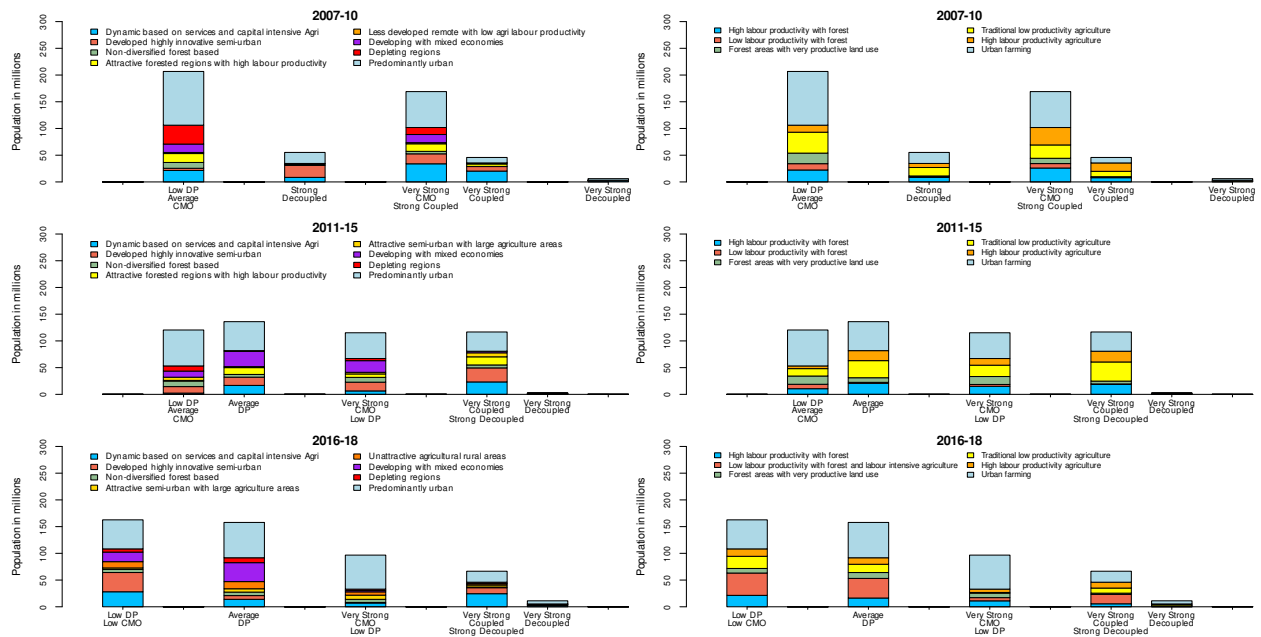
Figure 12 depicts the composition of the population benefiting from the different CAP policy-mixes in each period. The colours in the bars indicate the population provenance in terms of rurality cluster such that the bars' height shows the total population in the cluster. Some bars have zero height since the CAP policy mixes, and the rurality clusters are period-specific. Similarly, the rurality clusters composition changes across periods.

The left panel of Figure 12 shows the multidimensional rurality clusters' population across the CAP clusters. The histograms show how the CAP profiles of the more developed regions differ from the developing ones. While the *Predominantly urban*, *Dynamic based on services and capital intensive Agri*, *Developed highly innovative semi-urban*, and *Attractive forested*

<sup>23</sup>Two alternative metrics for this relation are: the number of NUTS3 regions or the area occupied by them. However, this analysis is provided by the maps in Sections 3 and 4. In addition, the number of NUTS 3 regions provides a very similar description of the relationship as when the variable population is used.

regions with high labour productivity tend to benefit from policy mixes with a relatively low Pillar 2 intensity, the *Developing with mixed economies* and *Depleting regions* exhibit a policy mix where Pillar 2 programs ( *Strong Pillar 2-Low Pillar 1*, *Very Strong Pillar 2*, or *Strong DP*) have more weight.

Figure 13: Multidimensional (left panel) and Agri-sector based (right panel) rurality clusters composition (in population) of Pillar 1 clusters by period



Note: CMO (Common Organisation of Markets/Markets Measures); DP (Direct Payments).

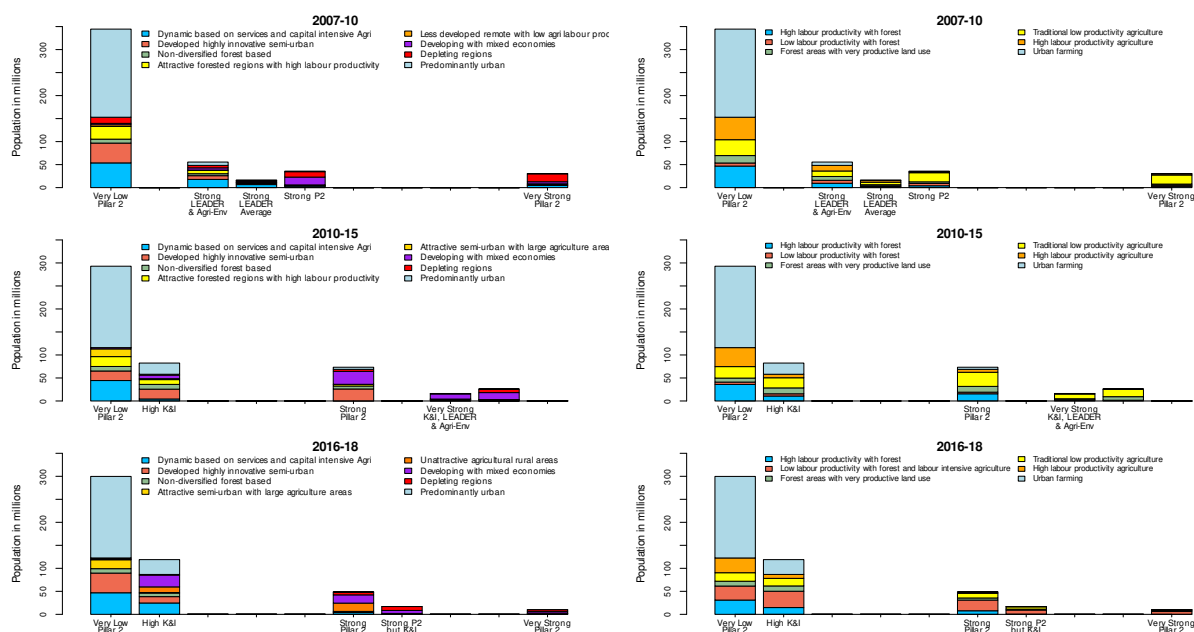
This pattern appears stable across clusters and periods, except for *Developing with mixed economies* territories, which, in the last interval, begins to benefit from Pillar 1 programs. Another interesting observation is that in the period 2007-2010, the *Developed highly innovative semi-urban* regions were receiving relatively low Pillar 2 and high Pillar 1 funds. This pattern is different in the following two periods (2010-15 and 2016-18), where the regions in this rurality cluster seem to benefit also from strong Pillar 2 measures.

The right panel of the Figure shows the agri-sector based rurality clusters population composition of the CAP clusters. The histograms confirm previous evidence that high labour productivity regions benefit from policy mixes characterised by *Low Pillar 2* measures. In contrast, the populations of areas described as *Traditional low productivity agriculture* benefit from *Low Pillar 2* measures above the average. It is worth noting that in the period 2016-18, the *Low labour productivity with forest* regions seem to be linked to all CAP classifications/clusters, which is not the case for the previous two periods.

Figure 13 shows the rurality clusters' population composition of the Pillar 1 clusters. The figures' left panel show that in the first period (2007-10), the majority of the population benefited from the 'traditional' CAP policies, i.e. *Average CMO*, and *Strong Coupled*. In the second pe-

riod, the population is uniformly divided into four policy mixes, although there is an increased relevance of Decoupled programs. From 2016 to 2018, a large part of the population is under the Pillar 1 policy-mix, as demonstrated by the beneficiaries of the *Low Pillar 1* policy-mix.

Figure 14: Multidimensional (left panel) and Agri-sector based (right panel) rurality clusters composition (in population) of Pillar 2 clusters by period



Note: Agri-Env (Agri-Environmental); K&I (Knowledge & Innovation); P2 (Pillar 2).

The *Predominantly urban regions* during the first period are mainly associated to clusters where the CMO play a relevant role. These regions benefit from policy mixes with a stronger Pillar 1 composition in successive second and third periods.

The *Developed highly innovative semi-urban regions* and *Dynamic based on services and capital intensive agri* regions, which during the first two periods benefited Coupled and Decoupled programs, in the last period exhibit a predominant Low Pillar 1 composition.

The right panel shows the agricultural sector based rurality cluster composition of the CAP clusters. The results are similar to the multidimensional clusters. The *Low labour productivity with forest* regions are linked to almost all CAP clusters in the last period, which is not the case for the previous two periods. That cluster probably includes some areas from *traditional low productivity agriculture*. The two profiles are, in fact, very close.

Figure 14 depicts the results of the analysis for the Pillar 2 clusters. The figure shows that in all three periods, the vast majority of the population has been benefited from the *Very low Pillar 2* type policy mix. Part of these clusters is also intaken over the average on selected Pillar 2 programs, such as the *High K&I* and *Strong LEADER and Agri-Env*. On the other hand, Strong or Very strong Pillar 2 programs benefited mostly populations within *Developing with mixed*

*economies and Depleting regions.*

The right panel of the Figure 14 shows that the *Traditional low productivity agriculture* and *Low labour productivity with forest* are the regions that benefited relatively more from Pillar 2 programs. The observation concerning the confluence of the areas of the cluster *Traditional low productivity agriculture* in the cluster *Low labour productivity with forest* also holds in this case.

## 6 Conclusions

The CAP has since its early stages taken an essential role in shaping the economic EU territory. Initially, it has been the EU strategy to support the challenges facing the agricultural sector and farmers in particular through several measures: direct income support, assistance in case of market disturbances caused by natural and economic events and promote the sector's competitiveness. However, the CAP has adopted a broader approach to developing rural areas that go beyond supporting the agricultural sector throughout the years. Its Pillar 2 provides various measures designed to promote the competitiveness of agriculture, the sustainable management of natural resources and climate action and the balanced territorial development of rural areas. Consequently, the CAP has been in a constant process of modernisation and adaptation, being many policies within one policy that benefits almost the entire EU territory. In fact, the territorial nature of the CAP has a dual perspective. On the one hand, it is a geographically blind policy since it supports farmers wherever they are. On the other hand, its balanced territorial development objective targets regions lacking in crucial infrastructures, diversification of their economic activities and the sustainable management of natural resources and climate.

This report aimed at providing a statistical characterisation of the regional dimension of the CAP in the period 2007-2018 based on disaggregated data on CAP payments at the NUTS3 level. The report provides a multidimensional analysis to describe the territorial CAP implementation patterns of the EU28 regions. The time dimension describes and defines time intervals associated with CAP reforms. The policy mix dimension typifies the EU28 regions' CAP implementation choices through a finite set of combinations of groups of Pillar 1 instruments and Pillar 2 measures. And finally, the spatial dimension implements the notion of rurality as a determinant of the allocation of CAP funds. As such, the report presented for the first time insights on how the CAP reforms between 2007-2018 changed the CAP implementation patterns across the EU28 and how these changes relate to the regions' degree of rurality.

The report exploits the changes across time in the composition of the funds allocated to the EU NUTS3 regions to define three-time intervals characterised by the different CAP reforms: the *pre-Health check* period covering years 2007-2010; the *post-Health check* period covering years 2011-2015; and the *Greening Reform* period covering years 2016-2018. Using a PCA and a hierarchical cluster analysis on Pillar 1 and Pillar 2 measures, the report proposes a classification of the implementation patterns of the CAP across the three periods. In addition, under the previous methodology, a cluster analysis of the characterisation of the rurality degree is developed, capturing various dimensions of EU NUTS3 regions' (structural, socio-economic, geographical and agricultural). Finally, the report analyses the relationship between the EU NUTS3 regions' rurality characterisation and chosen CAP mixes.

The analysis provides clear insight on how the CAP reforms objectives have been achieved at the regional level. It documents the spatial pattern of important landmarks of the policy. It de-



scribes the *external convergence* process, the increase of *Direct Payments* in replacement of *Market Measures*, the relatively slow process of *Decoupling* and the different regional patterns of Pillar 2 investments.

Because of the considerable socio-economic differences across the EU NUTS 3 regions the multidimensional analysis of CAP funds provides evidence about territorial imbalances in the incidence of CAP support. The territorial level adopted, i.e. NUTS 3 level, allows the exploration of the extent to which CAP expenditures are actually undertaken by rural and agricultural EU regions compared to urban ones.

This report provides an in-depth exploratory data analysis of the three heterogeneity dimensions of the CAP: time, policy mix and space. The study results are informative on the relevance and coherence of the policy as it links the funds to the territorial characteristics. Furthermore, this approach provides a framework with which the CAP can be evaluated. Quantifying the regional dimension of the CAP is, therefore, a valuable exercise for the policy process.

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## List of Abbreviations

- CAP** Common Agricultural Policy
- CMO** Common Market Organization
- DP** Decoupled Direct Payments
- EAFRD** European Agricultural Fund for Rural Development
- EAGF** European Agricultural Guarantee Fund
- EU** EU European Union
- EU28** European Union - 28 countries
- GDP** Gross Domestic Product
- GVA** Gross Value Added
- JRC** JRC Joint Research Center
- MS** Member States
- NMS** New Member States
- OMS** Old Member States
- NUTS2** Nomenclature of Territorial Units for Statistics - Level 2
- NUTS3** Nomenclature of Territorial Units for Statistics - Level 3
- P1** Pillar 1
- P2** Pillar 2
- PCA** Principal Component Analysis
- PPS** Purchase Power Standard
- RD** Rural Development
- RDP** Rural Development Plan

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## **Annexes**

### **A Grouping Pillar 2 measures**



Table A1: Pillar 2 groups: 2007-13 and 2014-20 Programming Periods

Categories	Groups	Measures Programming Period 2007-2013		Correspondence, as set out in Annex of R.(EU) 807/2014		Measures Programming Period 2014-2020	
		Codes				Codes	
Competitiveness	Private investments	121	Modernisation of agricultural holdings	4.1		4	Investments in physical assets (Article 17)
		123	Adding value to agricultural and forestry products	4.2			
		125	Infrastructure related to the development and adaptation of agriculture and forestry	4.3			
		216	Non-productive investments	4.4		8	Investments in forest area development and improvement of the viability of forests (Articles 21 to 26)
		122	Improvement of the economic value of forests	8			
		221	First afforestation of agricultural land	8			
		222	First establishment of agro-forestry systems on agricultural land	8			
		223	First afforestation of non-agricultural land	8			
		226	Restoring forestry potential and introducing preventive actions	8.3	8.4		
		227	Non-productive investments	8.4			
	131	Meeting standards	98		98	Meeting standards based on Union legislation	
	112	Setting up of young farmers	6.1		6	Farm and business development (Article 19)	
	311	Diversification into non-agricultural activities	6.4				
	312	Support for business creation and development	6.4				
	313	Encouragement of tourism activities	6	7.5 16			
New Businesses	141	Semi-subsistence farming (only for NMS)					
	144	Holdings undergoing restructuring due to a reform of a common market organisation (only for NMS)					
Risk management	113	Early retirement	97		97	Early retirement	
	126	Restoration and prevention actions	5		5	Restoring agricultural production potential damaged by natural disasters and catastrophic events and introduction of appropriate prevention actions (Article 18)	
Knowledge & Innovation	111	Training and information	1.1		17	Risk management (Articles 36 to 39)	
	331	Training and information (a training and information measure for economic actors operating in the fields covered by axis 3)	1.1		1	Knowledge transfer and information actions (Article 14)	
	114	Use of advisory services	2		2	Advisory services, farm management and farm relief services (Article 15)	
	115	Setting up of farm management, relief and advisory services	2				
	124	Cooperation for development of new products, processes and technologies	16		16	Co-operation (Article 35)	
	132	Food quality schemes	3		3	Quality schemes for agricultural products and foodstuffs (Article 16)	
	133	Information and promotion for products under food quality schemes	3				
	143	Provision of farm advisory and extension services in Bulgaria and Romania			99	Skills acquisition, animation and implementation of local development strategies	
	341	Skills acquisition, animation and implementation	99		20	Technical assistance	
	511	Technical assistance	20	6 17	9	Setting up of producer groups and organisations (Article 27)	
Agri-Environment	213	Natura 2000 and payments linked to Directive 2000/60/EC	12		12	Natura 2000 and Water Framework Directive payments (Article 30)	
	214	Agri-environment payments	10	11	10	Agri-environment-climate (Article 28)	
	215	Animal welfare payments	11		11	Organic farming (Article 29)	
	224	Natura 2000 payments	14		14	Animal Welfare (Article 33)	
	225	Forest-environment payments	12		12	Natura 2000 and Water Framework Directive payments (Article 30)	
Public Investment	321	Basic services for the economy and rural population	15		15	Forest environmental and climate services and forest conservation (Article 34)	
	322	Village renewal and development	7.1		7	Basic services and village renewal in rural areas (Article 20)	
	323	Conservation and upgrading of the rural heritage	7.6				
LEADER	411	Implementing local development strategies. Competitiveness	7.6		19.2		
	412	Implementing local development strategies. Environment/land management	7.6		19.2		
	413	Implementing local development strategies. Quality of life/diversification	19.2		19.2		
	421	Implementing cooperation projects	19.3		19.3		
	431	Running the local action group, acquiring skills and animating the territory	19.4		19.4		
Decoupled Payments	Least Favoured Areas	211	Natural handicap payments in mountain areas	13		13	Payments to areas facing natural or other specific constraints (Articles 31 and 32)
		212	Natural handicap payments in areas other than mountain areas	13			
		611	Complement to direct payment			18	Croatia Direct payments - areas

## B Principal Component Analysis: some methodological details and results

This annex provides some methodological details about the Principal Component Analysis (PCA).<sup>24</sup>

Principal Component Analysis (PCA) transforms a large set of variables into a smaller one while preserving as much as information as possible from the large dataset. The algorithm of the PCA applied in this work is as follows:

Step 1: '*Standardisation of the variables*'. Standardisation of the input variables prevents variables with high values-range to dominate the other variables and hence, to bias the results. The following formula is applied to each value of each variable in order to homogenize their scale:

$$\text{standardised value} = \frac{\text{value} - \text{mean}}{\text{standarddeviation}} \quad (1)$$

Step 2: '*Computation of the covariance matrix*'. The covariance matrix shows the correlations between all the possible pairs of variables. High correlation implies that the information contained in the two variables is redundant.

Step 3: '*Computation of the eigenvalues and eigenvectors of the covariance matrix*'. In this way, the Principal Components (PCs) are identified i.e. the linear combinations of the initial variables that include the maximum possible information of all the initial variables. This also results to a dimensionality reduction because the principal components put together the variables that capture most information of the data in the following way: When choosing to keep the first  $x$  eigenvectors out of  $n$  (ordering them by their eigenvalues in descending order), one chooses to keep the  $x$  linear combinations of the initial variables with the most information (variance). The ordering of the eigenvectors is based on their respective eigenvalues because the eigenvalues measure the amount of variance of the initial variables that is captured by the Principal Components (linear combinations).

Step 3: '*Reorientation of the data along the PCs axes*'. This step is about transforming the initial axes of the data (i.e. the axes in terms of the initial variables) to the new axes represented by the PCs. This is done using the following formula:

$$\text{New dataset} = \text{Eigenvectors Matrix}^T * \text{Standardised values Matrix}^T \quad (2)$$

Tables A2 - A4 show the Principal Components of the (a) mixed Pillar 1 and Pillar 2; (b)

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<sup>24</sup>For a comprehensive review on the use of PCA in cluster analysis see for example Dunteman (1989).

Multidimensional; and (c) Agricultural based approaches, which were extracted applying the Guttman-Kaiser criterion (i.e., keeping the PCs that explain 70-80% of the cumulative variance) and their coefficients of the linear combination of the original input variables from which the PCs are constructed (PC loadings). The numbers in the Tables (PC loadings) are the correlation coefficients between the original variables and the PCs. Their sign and magnitude feeds the attributed labeling to the extracted PCs. For illustrative purposes and to save space, this annex includes the Tables only for the PCA applied in data for the year 2007. The results/Tables for the years 2010 and 2015 are available upon request.

Table A2: Principal component loadings for the mixed Pillar 1 and Pillar 2 approach

Variable	PC1	PC2	PC3
Market Measures	-0.046	-0.044	0.960
Coupled Direct Payments	0.169	0.597	-0.026
Decoupled Direct Payments	0.096	0.662	-0.025
Competitiveness (P2)	0.540	-0.115	0.119
LEADER (P2)	0.537	0.063	0.156
Public Investment (P2)	0.356	-0.430	-0.186
Agri-Environment (P2)	0.504	0.029	-0.061

After the extraction of the PCs, this work applies Ward's criterion to hierarchical cluster analysis for choosing the pair of clusters to merge at each step based on the minimisation of the within-cluster variance. Tables 1, 4 and 5 in the main text summarise with heat map visualisations the average values of the variables that have been included in the PCA and characterise the typologies across the (a) mixed Pillar 1 and Pillar 2; (b) Multidimensional; and (c) Agricultural based approaches, respectively.

Table A3: Principal component loadings for the multidimensional approach

Variable	PC1	PC2	PC3	PC4	PC5	PC6	PC7
GDPpc (PPS)	0.362	0.291	0.026	0.059	0.007	-0.024	0.042
GVA Agri per Empl	0.288	0.209	-0.166	-0.089	0.251	0.152	0.427
GVA Agri per AA	0.097	0.141	0.236	0.283	0.520	0.180	0.348
Empl per AA	-0.228	-0.155	0.333	0.329	0.176	-0.024	-0.131
GVA share Agri	-0.320	-0.107	-0.091	0.039	0.135	0.425	0.278
GVA share Ind	-0.002	-0.113	0.365	-0.138	-0.233	-0.160	0.534
Pop dens	0.305	-0.259	0.167	0.332	0.124	-0.157	-0.135
Birth rate	0.081	-0.014	-0.327	0.195	-0.126	-0.386	0.197
Net migr	0.196	0.208	-0.160	-0.120	0.193	0.086	-0.383
EU TM	0.276	0.052	0.212	0.158	-0.394	0.351	-0.070
CD	0.245	0.040	0.261	0.118	-0.452	0.315	0.003
Forest	-0.181	0.452	0.328	-0.094	0.022	-0.187	-0.092
Artif	0.275	-0.306	0.105	0.304	0.172	-0.258	-0.067
Agri	0.135	-0.445	-0.344	0.000	-0.056	0.272	0.085
Mega1	-0.314	0.060	-0.224	0.437	-0.167	0.032	-0.029
Mega2	-0.171	-0.255	0.271	-0.172	0.193	0.291	-0.217
Mega3	-0.290	0.205	-0.057	0.421	-0.165	-0.002	0.112
Mega4	0.096	0.288	-0.165	0.280	0.095	0.270	-0.164

Notes: GDPpc (PPS) (GDP per capita in PPS); GVA Agri per Empl (GVA of agricultural sector by employment in agriculture); GVA Agri per AA (GVA of agricultural sector by agricultural area); Empl per AA (Employment in agricultural sector by agricultural area); GVA share Agri (Share of GVA of agriculture); GVA share of Ind (Share of GVA of industry); Pop dens (Population density); Net migr (Net migration); EU TM (EU Trademark); CD (Community Design); Forest (Forest area percentage); Artif (Artificial area percentage); Agri (Agricultural area percentage); Mega1 (Distance to Mega 1 city); Mega2 (Distance to Mega 2 city); Mega3 (Distance to Mega 3 city); Mega4 (Distance to Mega 4 city).

Table A4: Principal component loadings for the agricultural based approach

Variable	PC1	PC2	PC3	PC4
GVA Agri per Empl	0.217	0.605	0.052	0.416
GVA Agri per AA	-0.093	0.309	0.702	0.303
Emp Agri per AA	-0.257	-0.423	0.552	-0.190
GVA share Agri	-0.154	-0.449	0.093	0.666
Forest	-0.612	0.238	-0.073	-0.098
Artificial	0.389	0.100	0.432	-0.458
AA	0.573	-0.302	-0.004	0.192

Notes: GVA Agri per Empl (GVA of agricultural sector by employment in agriculture); GVA Agri per AA (GVA of agricultural sector by agricultural area); Empl Agri per AA (Employment in agriculture by agricultural area); GVA share Agri (Share of GVA in agriculture); Forest (Forest area percentage); Artificial (Artificial area percentage); AA (Agricultural area percentage);

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