

Raising farm labour productivity in the EU: data, estimation and CAP mapping

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This supplement records what Policy Brief 004 adds to Krisztin, Renhart and Piribauer (2026, *Agricultural Economics*), and the source of every number the brief states. Payment data are the paper's CATS extract, covered by Agreement IFD 2023_LAMASUS (clause 2: no disaggregated CATS data to third parties). Neither the brief, this supplement nor the viewer reports a CAP payment for any individual region; the most disaggregated payment figures published are the sample-wide moments in Section 3., which do not violate the data's confidentiality clause.

1 Regressions beyond the paper

The brief uses the paper's OLS specification (model iii) unchanged: all 15 payment categories enter jointly, with country and year fixed effects. For region i , year t and horizon $h \in \{1, 3, 5\}$,

$$y_{it}^{(h)} = \sum_k \beta_k^{(h)} s_{kit} + x'_{it} \gamma^{(h)} + \alpha_{c(i)} + \tau_t + \varepsilon_{it}, \quad s_{kit} = P_{kit} / V_{it},$$

where P_{kit} is payments through category k (EU share plus national co-financing at each RDP's rate) and V_{it} agricultural gross value added. Controls x_{it} : log initial labour productivity, log population density, grassland share of grassland plus cropland, mean daily maximum temperature, primary and tertiary shares of total employment, share of holdings above 50 ha, elevation, and other ESI funds relative to value added (NUTS-2). A coefficient reads as percentage points of annual growth per percentage point of agricultural value added paid.

What is new relative to the paper.

- **Two additional dependent variables.** The paper estimates labour-productivity growth only. The brief adds annualised growth of value added, $(1/h)[\log V_{i,t+h} - \log V_{it}]$, and of employment, $(1/h)[\log L_{i,t+h} - \log L_{it}]$, with identical regressors and sample. OLS is linear in the dependent variable, so $\beta^{LP} = \beta^{VA} - \beta^{EMP}$ holds exactly. The split shows which margin carries an association; it is an accounting identity, not a separate test.
- **New outcome data** (Section 2). Specification and payment data are the paper's; the outcome series are ARDECO 2024. This alone moves the estimates away from the published ones (table below).
- **Reporting.** Figure 2 shows 10 of the 15 jointly estimated categories. The other five (Natura 2000, cooperation, diversification, technical assistance, general rural development with risk management) are in every regression but not reported.
- **Inference.** Heteroskedasticity-robust (HC1) standard errors; 95% intervals are ± 1.96 SE; "significant" means $|t| > 1.96$. As a check, standard errors clustered by NUTS-3 region were also computed (ratio to HC1: median 1.11, range 0.36–1.93). Of the statements in the brief, one does not survive clustering at 5%: forestry and employment at $h = 5$ (t 2.07 under HC1, 1.47 clustered).

Region and time period sampling: Exclusion rule as in the paper: a region is dropped if it is predominantly urban (Eurostat urban–rural typology, NUTS 2016) and its agricultural share of value added is at or below 1% in at least one year. Recomputed on the new data this leaves 958 regions at $h = 1$ and 950 at $h = 3, 5$ (Sardinia, ITG2, dropped at $h > 1$ as in the paper's replication code); the paper has 957 and 949. Base years run 2009–2017 ($h = 1, 3$) and 2009–2015 ($h = 5$), giving 8,622, 8,550 and 6,650 observations; the last outcome year is 2018 at $h = 1$ and 2020 at $h = 3$ and 5.

All estimates shown in Figure 2. Coefficient, HC1 standard error in brackets; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Instrument (paper variable)	h	Labour productivity	Value added	Employment
Decoupled Direct Support (DABIS) (DECOUP)	1	+0.184*** (0.032)	+0.203*** (0.033)	+0.019* (0.010)
	3	+0.061*** (0.016)	+0.086*** (0.017)	+0.025*** (0.005)
	5	+0.030*** (0.007)	+0.042*** (0.007)	+0.012*** (0.004)
Farm Investments (PC)	1	+0.012 (0.017)	−0.002 (0.019)	−0.014 (0.012)
	3	+0.017* (0.009)	+0.006 (0.007)	−0.011 (0.009)
	5	+0.017*** (0.004)	+0.006 (0.006)	−0.011** (0.005)
Agri-Environmental & Climate Actions (AEP)	1	−0.133 (0.082)	−0.088 (0.085)	+0.044 (0.038)

Instrument (paper variable)	h	Labour productivity	Value added	Employment
	3	-0.056 (0.040)	-0.061 (0.044)	-0.006 (0.020)
	5	-0.046 (0.028)	-0.037 (0.031)	+0.009 (0.018)
Payments for Natural Constraints (ANC) (LFA)	1	-0.023 (0.051)	+0.052 (0.047)	+0.075*** (0.026)
	3	-0.020 (0.024)	+0.044* (0.023)	+0.064*** (0.013)
	5	-0.041* (0.024)	+0.003 (0.021)	+0.045*** (0.015)
Coupled Income Support (CIS) (COUP)	1	-0.221*** (0.059)	-0.207*** (0.056)	+0.014 (0.024)
	3	-0.101*** (0.029)	-0.156*** (0.026)	-0.055*** (0.017)
	5	-0.125*** (0.019)	-0.141*** (0.018)	-0.016 (0.010)
Market Measures (MARKET)	1	+0.009 (0.011)	+0.008 (0.007)	-0.001 (0.005)
	3	+0.006** (0.002)	+0.008*** (0.003)	+0.002 (0.002)
	5	+0.003* (0.002)	+0.006*** (0.002)	+0.003*** (0.001)
Forestry Investments (FOR)	1	+0.202 (0.188)	+0.270 (0.182)	+0.068 (0.094)
	3	+0.148 (0.105)	+0.230** (0.111)	+0.082 (0.069)
	5	+0.273** (0.110)	+0.414*** (0.133)	+0.141** (0.068)
Knowledge Sharing & Innovation (AKIS) (HC)	1	+0.687*** (0.264)	+0.566** (0.228)	-0.121 (0.151)
	3	+0.298** (0.126)	+0.176 (0.110)	-0.122* (0.072)
	5	+0.634*** (0.085)	+0.707*** (0.067)	+0.073 (0.059)
Early Retirement Support (EARLY)	1	-0.505 (0.315)	-0.584** (0.276)	-0.079 (0.205)
	3	-0.671*** (0.142)	-0.632*** (0.119)	+0.039 (0.101)
	5	-0.368*** (0.134)	-0.820*** (0.097)	-0.451*** (0.112)
Organic Farming Support (ORGANIC)	1	-0.320 (0.434)	-0.407 (0.269)	-0.087 (0.379)
	3	+0.032 (0.157)	-0.260* (0.140)	-0.292** (0.115)
	5	-0.799*** (0.219)	-0.461** (0.222)	+0.338*** (0.104)

Source: out/clustered_se.csv (columns est, se_hc1), written by R/05_inference.R; Figure 2 is drawn from the same file by R/03_figures.R.

2 Data beyond the paper

Series	Source and unit	Used for
Employment	ARDECO SNETZ, versions_2024; persons employed (thousand), NACE A, NUTS-3	All employment growth and all labour-productivity figures
GVA, current prices	ARDECO SUVGZ, versions_2024; million EUR, NACE A	Figure 2 regressions (outcome and the denominator of every payment share); viewer: 2024 national GVA for scaling
GVA, 2015 prices	ARDECO SOVGZ, versions_2024; million EUR2015, NACE A	Figure 1, all descriptive statistics in the text, viewer map and country tiles
NUTS 2016–2024 overlap	Eurostat/GISCO NUTS-3 polygons, 1:10M, EPSG:3035 (Nuts2json release)	Converting ARDECO to NUTS 2016 for the descriptive statistics
CAP Strategic Plans 2023–27	DG AGRI CSP master file (adopted plans), sheet General_financial_information	Section 5 and the viewer baseline
FADN; USDA ERS IAP	See Section 3	Two context statistics in the brief's introduction

Price basis: The Figure 2 regressions use value added in current prices; the descriptive statistics and Figure 1 use 2015 prices. With current prices, payment shares and outcomes share one nominal basis. Price movements common to all regions in a year are absorbed by the year effects, and time-invariant differences in national inflation by the country effects; country-specific changes in inflation over time are not absorbed.

Data merge: ARDECO values replace the paper's panel values wherever ARDECO reports a positive value. For the regressions the join is on the NUTS code as published; 57 sample regions in BE, DE, EE, FI, IT, LV, NL and PT whose code changed between NUTS 2016 and 2024 keep the paper's panel series. For the descriptive statistics ARDECO is

first converted to NUTS 2016: each 2024 region is split across the 2016 regions it overlaps in proportion to area share times the 2016 region's mean 2015–19 value, overlaps under 3% of the 2024 region are dropped as slivers, and the parts are summed (R/00_prep.R, ardeco_to_nuts2016). After conversion only MT002 lacks data after 2020. The descriptive sample is 955 regions.

Time period: The paper ends in 2020. The descriptive statistics run to 2024; the regressions do not, because the CATS extract ends in 2020.

3 Headline numbers and their sources

Growth rates are compound annual rates between end-years. “National total” means value added and employment summed over a country's sample regions before taking the ratio.

Statement in the brief	Value	Source and computation
Own calculations, ARDECO (2015 prices)		
Median EU country: labour productivity, value added, workforce (Key message 1)	2.0 → 0.8; 1.3 → -0.4; -0.8 → -1.1 % a year	Median across countries of national totals, 2010–19 (26 countries) and 2020–24 (25; Malta has no data after 2020)
EU labour productivity, value added, workforce	3.1 / 1.9; 0.9 / 0.1; -2.2 / -1.8 % a year	Sum over sample regions with data at both end-years (955 in 2010–19, 954 in 2020–24)
Workforce share of productivity growth	about 70% / about 95%	Workforce decline over productivity growth: 2.18/3.11 and 1.76/1.86
Catch-up: half the level, about 1.2 points faster; gone after 2020	-1.76 (SE 0.15) × ln 2 = 1.22; 2020–24: +0.50 (SE 0.39)	OLS of regional annual growth on log initial level, regions between the 5th and 95th percentile of the initial level (859 and 858 regions); the Figure 1 fit
Austria, Hungary, Poland (text and Figure 1, right)	e.g. Poland 2020–24: +6.0, +0.5, -5.2	National totals; out/country_stats.csv, columns *_p1_total, *_p2_total
Own calculations, CATS and ARDECO (current prices)		
Mean shares in Figure 2 labels; “CIS averaging 2%”; “AKIS 0.3% of value added”	DABIS 21.3, Farm investment 2.7, AECA 2.7, ANC 2.2, CIS 2.0, Market 1.5, Forestry 0.33, AKIS 0.32, Early retirement 0.22, Organic 0.22 (%)	Region-year means over the h = 1 estimation sample (8,622 obs., 2009–17). Means exceed medians for the small instruments: AKIS median 0.05%, 90th percentile 0.86%
Coefficients quoted in text, key messages and policy options	Section 1 table	out/clustered_se.csv, HC1
External statistics		
Labour is 22.8% of production costs on average	22.8% (median 18.5%)	FADN (DG AGRI), LAMASUS calculation over FADN regions, 1990–2020. Labour cost = wages paid (SE370) + family labour units × regional wage per AWU; total cost adds intermediate inputs, land (rent paid + imputed rent on owned land) and capital (depreciation + interest + 4% on machinery and buildings). Unweighted mean of region-year shares
Labour productivity is the fastest-growing component of EU agricultural productivity	EU-27, 1990–2020: output per worker +3.05, TFP +1.82, output per hectare +0.67 % a year	USDA ERS, International Agricultural Productivity data set (July 2023 release); log-linear trends
Coupled-support ceiling 13% → 20%, plus 5% for sectors and regions in need	13%; 20% + 5%	Current: Reg. (EU) 2021/2115, Art. 96 (13%, plus 2% for protein crops). Proposed: European Commission (2025), Q&A of 23 July 2025. The ceiling is not in the draft CAP regulation COM(2025) 560 itself
2028–34: National and Regional Partnership Plans; Member States choose the mix	–	COM(2025) 560 final (16 July 2025) and European Commission (2025)
2014–20 rules extended to 2022; Strategic Plans from 2023	–	Reg. (EU) 2020/2220 (transition); Reg. (EU) 2021/2115 (Strategic Plans)
Commission vision calls for more farmers	–	A Vision for Agriculture and Food, COM(2025) 75 final, 19 February 2025

4 Crosswalk: paper categories to post-2027 CAP interventions

CATS measure codes are those of the paper's Annex B (three digits: 2007–13 RDP measures; M-codes: 2014–20; six digits: EAGF budget lines). Post-2027 interventions are the types of support in Art. 5(1) of COM(2025) 560. The match is by intervention logic, not legal identity.

Paper variable	CATS codes	Brief label (Figure 2)	COM(2025) 560 intervention
DECOUP	050301	Decoupled Direct Support (DABIS)	Degressive area-based income support, Art. 6
COUP	050302	Coupled Income Support (CIS)	Coupled income support, Art. 11
MARKET	050201–050218	Market Measures	Interventions in certain sectors, Art. 5(1)(r) (Reg. 1308/2013)
AEP	214, 215, 216; M10, M14	Agri-Environmental & Climate Actions	Agri-environmental and climate actions, Art. 10
ORGANIC	M11	Organic Farming Support	Agri-environmental and climate actions, Art. 10
LFA	211, 212; M13	Payments for Natural Constraints (ANC)	Payment for natural or other area-specific constraints, Art. 8
PC	121, 123–126; M04, M05	Farm Investments	Investments for farmers and forest holders, Art. 13
FOR	122, 221–227; M08, M15	Forestry Investments	Art. 13 (forest holders); forest-environmental commitments under Art. 10
HC	111, 112, 114, 115, 143; M01, M02	Knowledge Sharing & Innovation (AKIS)	Knowledge sharing and innovation, Art. 19; AKIS and advisory services, Art. 20
EARLY	113; M113	Early Retirement Support	No equivalent. Related: setting-up and generational renewal, Art. 14–16; Art. 6(6) ends DABIS for pensioners by 2032
Estimated but not shown in Figure 2			
N2K	213; M12	–	Disadvantages from certain mandatory requirements, Art. 9
COOP	131–133, 142; M03, M09, M16	–	Territorial and local cooperation initiatives, Art. 5(1)(n)
DIV	311–313; M06	–	Setting-up of young farmers, new farmers, rural business start-up, Art. 14
GRD + RISC	321–341, 411–431; M07, M19; M17	–	LEADER, Art. 18; risk management tools, Art. 12
TA	511; M20	–	Technical assistance (no CAP intervention type)

Setting-up aid for young farmers sits in HC for 2007–13 (code 112) but in DIV for 2014–20 (M06). Eco-schemes (2023 onwards) have no CATS predecessor; Section 5 maps them to agri-environmental and climate actions.

5 Current CAP allocations mapped to post-2027 groups

Source: DG AGRI CSP master file, sheet General_financial_information, grouped by R/generate_cap_allocations_excel.R into data/CAP_Allocations_by_MS_Paper_and_MFF.xlsx (sheet Annual_Baseline_EUR). Direct payments: EU funds, indicative allocations for claim years 2024–2028, divided by 5. Rural development: total public expenditure (EAFRD plus national co-financing) for the 2023–27 plans, divided by 5. Sectoral interventions and technical assistance are not included. Figures are € million a year; Belgium is Flanders plus Wallonia.

CSP line (Reg. 2021/2115)	Post-2027 group (viewer pot)	Estimate applied	EU-27	AT	HU	PL
BISS, CRISS, CIS-YF (Art. 21, 29, 30)	DABIS	DECOUP	24,040	560	929	2,079
Coupled income support (Art. 32–35)	CIS	COUP	4,606	18	199	520
Eco-schemes (Art. 31) + ENVCLIM (Art. 70)	Agri-env. & climate	AEP	15,585	572	580	1,197
ANC (Art. 71)	ANC	LFA	3,743	198	0	296
Investments (Art. 73–74)	Farm investment	PC	6,276	198	112	501
Installation (Art. 75) + knowledge (Art. 78)	AKIS	HC	1,450	57	35	155
ASD (Art. 72), risk (Art. 76), cooperation incl. LEADER (Art. 77)	Other	none (zero)	3,316	108	106	234
Total			59,016	1,711	1,960	4,981
CIS as % of direct payments			12.3	2.7	15.0	15.0
Total as % of 2024 agricultural GVA (current prices)			–	28.5	35.1	22.9

The eco-scheme budget (EU-27: €8,943 M a year, 57% of the agri-environment group) is assigned the AEP coefficient, which was estimated on Pillar II commitments only. The installation budget is assigned the HC coefficient, although in 2014–20 installation aid was in DIV. Organic support is inside ENVCLIM and so takes the AEP coefficient, not the ORGANIC one. Hungary’s ANC line is empty in the master file.

6 CAP Productivity Explorer

Built by viewer/build_viewer.py (Python standard library) from the outputs of the R pipeline; the page embeds all data, fonts and d3, and loads nothing from third-party servers.

Element	Data and computation
Map	ARDECO SOVGZ (2015 prices) and SNETZ, converted to NUTS 2016 (Section 2); out/nuts3_stats.csv from R/02_descriptives.R. Compound annual growth of value added, employment and labour productivity for 2010–19 and 2020–24; productivity level (k€ per person) in 2019 or 2024. 955 sample regions; excluded regions grey.
Country and EU tiles	National and EU totals summed over sample regions with a complete, positive 2010–2024 series in ARDECO’s own codes; median NUTS-3 region within the country from nuts3_stats.csv. This join does not use the NUTS conversion, so 58 sample regions without a complete series under their 2016 code (the recoded regions of BE, DE, EE, FI, IT, LV, NL and PT, and MT002) are missing from the tiles, and the EU tile covers 897 regions: 3.0 / 0.9 / –2.1 % a year for 2010–19 against the brief’s 3.1 / 0.9 / –2.2; 2020–24 is identical (1.9 / 0.1 / –1.8).
Baseline CAP mix	Section 5, seven pots per country (€ M a year).
Sliders	Budget-neutral: moving one pot changes the others in proportion to their size, bounded at zero and at the envelope. Square-root slider scale so that small pots can be set.
Scaling to the regressor	$\Delta Z_k = (\epsilon_k - \epsilon_k^{CSP}) / V_{c,2024} \times 100$, in percentage points of national agricultural GVA in 2024, current prices (ARDECO SUVGZ, NUTS-0); the same nominal basis as the payment shares in the regressions.
Impact after h years	$\Delta_h = h \sum_k \beta_{k,h} \Delta Z_k$, for each outcome and $h = 1, 3, 5$; read as approximately % of the level reached, relative to the current plan. 95% interval: $\pm 1.96 h [\sum_k (\Delta Z_k se_{k,h})^2]^{1/2}$, HC1 standard errors, covariances between instruments ignored. β and se from out/clustered_se.csv (est, se_hc1): the Figure 2 estimates. The “Other” pot has no estimate and no effect; market measures, forestry and early retirement are not sliders.
Warnings	Coupled support above 25% of the country’s direct payments (20% + 5%, Commission proposal). An increase in a pot larger than that instrument’s mean share in the estimation sample (DABIS 21, CIS 2, agri-env. 3, ANC 2, investment 3, AKIS 0.3 points), i.e. outside the range the estimates describe.
CATS compliance	NUTS-3 records carry only codes, names, productivity levels and growth rates; the build aborts if any other field appears. Payments enter only as published coefficients and national CSP allocations.

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