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Alternative EU CAP Tools for Stabilising Farm Incomes in the Era of Climate Change

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Geary WP2021/03
March 22, 2021

Alternative EU CAP Tools for Stabilising Farm Incomes in the Era of Climate Change*

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Abstract

No reliable supports protect EU farmers from the catastrophic risks which are expected to increase in frequency and severity due to climate change. We propose three transparent, predictable, and fair safety net policies which operate with indices on the Member State level. Simulations with a tailored global model of a series of historic yield shocks as observed over past decades serve as a test bed to quantify the costs and benefits of these policies in EU Member States using various risk metrics. The results highlight properties of and rankings among these polices useful for guiding future policy design and assessment.

Keywords: Safety nets; risk management; income stabilisation; climate change; EU Common Agricultural Policy

JEL classification: Q18; Q54

1 Introduction

Climate change is associated with rising mean temperatures and changes in weather patterns. In addition, climate researchers expect that extreme weather events, such as extreme heat, cold, droughts, floods, and storms, will increase in frequency and severity, see, e.g., Lewis and King (2017); Vogel et al. (2019).[1] Moreover, the effects of extreme events change with global warming as they impact on an environment under higher mean temperature.

These changes directly affect many lines of business but especially the agricultural sector where livestock and crop yields strongly depend on weather. Like other businesses, farmers are responsible to take measures to adapt in the best way to

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*Acknowledgements: The authors would like to thank the Edmund Rehwinkel Foundation of the Rentenbank (Frankfurt, Germany) for funding an earlier version of this study.

[1]Research on the detection of past trends in the occurrence of extreme weather events is hampered by data issues and not conclusive (Alexander, 2016; Easterling et al., 2016) but evidence is growing that occurrences have increased in frequency and intensity also over the past decades (EASAC, 2013, 2018; Heim, 2015; Kron et al., 2019; Lewis and King, 2017).

these changing climate conditions and limit the associated risks utilizing on-farm adaption and financial risk management options.

However, catastrophic risks concern crises caused by natural disasters and market disturbances which are beyond what farmers or markets can cope with and for which the insurance market often does not provide appropriate instruments. This can be regarded as a market failure (OECD, 2009). Governments regularly deal with such situations using safety nets and disaster relief, i.e., *ex-post* measures which mitigate negative effects for farmers directly during the period of crises (Cordier, 2015; OECD, 2009).

Considering that the frequency and intensity of extreme weather events might increase with climate change, together with the extraordinary exposure of farmers to such catastrophic risks, both the livelihoods of farmers and food security in general may be at stake (Haile et al., 2017; Schmidhuber and Tubiello, 2007; Wheeler and von Braun, 2013). Policymakers need to decide to what level safeguarding of agricultural producers from weather-caused crises is optimal for social welfare and how it can be delivered in practice. Policy needs to strike a balance between guaranteeing a sufficiently stable, sustainable income for farmers to ensure the sustainability of agriculture and food security in general on the one hand and avoiding incentives for overly risky behaviour (moral hazard) and the crowding-out of private market risk management instruments which would lead to inefficient markets (Cordier, 2015), on the other.

In the EU, the 2013 reform for the 2014 – 2020 Common Agricultural Policy (CAP) recognized the need to do more to limit farm income variability. Direct payments, now largely provided in form of payments decoupled from production in the Basic Payment Scheme[2] (BPS), make a significant contribution both to the level and stability of farm incomes. In addition, the EU retains intervention mechanisms for several key commodities which allow the public purchase of excess production when prices fall below safety-net levels. Two further initiatives introduced in that reform were a greater scope for individual EU Member States (MS) to finance risk management instruments through their Rural Development Programmes (RDP) and an EU-wide crisis reserve.

Unlike in the United States (US), risk management measures play a relatively minor role in the EU (Bardaji and Garrido, 2016). MS and farmers have made very little use of the CAP's new options to date for several reasons (van Asseldonk et al., 2019; ECoA, 2019; Meuwissen et al., 2018; European Commission, 2020; Cordier and Santeramo, 2020). First, farmers depend on their MS for implementing a corresponding policy. Second, the CAP only allows subsidising these risk management tools, such as the Income Stabilisation Tool (IST), within limits. This is much less

[2]For convenience, we refer to all decoupled payments including the BPS and the Single Area Payment Scheme as BPS in this paper.

attractive in comparison to the situation in the US where the 2014 Farm Bill supports farmers via two fully publicly funded safety net programmes, the Price Loss Coverage (PLC) and Agricultural Risk Coverage (ARC) programmes. Finally, another reason might be the existence of direct payments themselves. Survey data analysed by ECoA (2019) indicate that the incentive for taking out insurance is lower, the higher is the share of direct payments in total agricultural farm income. The stable direct payments income stream shifts the mean of farm income upwards, thereby reducing the income at risk in relation to total farm income (Tangermann, 2011).

The instrument for dealing with catastrophic risks introduced with the 2014–2020 CAP is the crisis reserve. This is established in the EU budget by withholding a part of the direct payments through the financial discipline mechanism that should not exceed 400 million Euro (in 2011 prices)[3] at the beginning of each year which, if not used, is refunded to farmers the following year. The crisis reserve has not been used since its introduction (European Commission, 2020). The main reason is that using the reserve implies effectively transferring part of direct payments from one group of farmers to another group and there has been no political will to implement this (Matthews, 2018). Moreover, the crisis reserve is missing clearly defined triggers for its activation (ECoA, 2019; European Commission, 2020), leaving farmers uncertain about which risks they need to manage themselves.

In the absence of crisis support from the EU, farmers depend on their national governments for aid. However, both the political appetite and the financial capacity of MS to support their farmers through state aid in case of severe crises can differ substantially and thereby distort competition between farmers within the EU. This becomes especially obvious when several sectors over larger regions are affected, like, for example, in 2018 when large parts of Northern and Eastern Europe experienced multiple and simultaneous harvest failures through drought (Beillouin et al., 2020).

Greater vulnerability of farm incomes in light of expected greater yield variability due to climate change and other factors, exacerbated by a lessening of the effect of the natural hedge because EU agriculture is now more exposed to international trade, necessitates a mechanism complementing current income support and risk management options in the EU for safeguarding the farming sector against catastrophic risks.

This study examines three alternative safety net policies for EU farming designed to protect entire sectors of all MS against crises drawing on the PLC and ARC models in the US and the IST in the EU, which protect farmers against price, revenue, and income risks, respectively. The payout trigger and calculation rules for

[3]See Articles 25 and 26 of Regulation (EU) No 1306/2013 and Article 8 of Regulation (EU) No 1307/2013.

our safety net policies are borrowed from those currently used in those schemes. These policies are intended as a complement (or replacement) of the current crisis reserve of the CAP to safeguard complete farming sectors from catastrophic risks. They thus contrast to the way those policies are currently implemented in the US and EU which aim to safeguard individual farmers.

While this study focuses on examining the use of these safety net instruments for protection from weather-induced livestock and crop yield shocks, this protection would reach beyond, covering also shocks originating from demand or inputs, e.g., those caused by pandemics or geopolitical tensions.

Both payout triggers and calculations are rule-based to establish a fair, transparent, and predictable mechanism. To ensure a level playing field across the EU, the policies are fully funded out of the CAP's BPS budget, similar to the current crisis reserve, and thus provide all EU farmers universally with a safety net. They are implemented as a social solidarity insurance among farmers where all farmers forego an equal share of their direct payments and all farmers are equally covered. Similar to the current CAP's crisis reserve, the new policies only reduce the CAP's BPS envelope to the extent safety net payments have been triggered somewhere within the EU. While safety net payments are automatically triggered and determined according to pre-defined rules, the responsibility for fairly distributing the support to farmers according to need is transferred to the respective MS's government, in line with the subsidiarity principle. To increase predictability for individual farmers, specific rules on which farmers could benefit and by how much when a MS is declared to have a catastrophic income risk would be set out in the relevant CAP legislation. Moreover, this proposal is coherent with the European Commission's goal to improve the results orientation of the CAP.

Unexpected agricultural production shocks do not allow major revision of the current year's planting decisions meaning that land and capital are largely committed with little option to change while labour could switch between productive activities. Correspondingly, agricultural markets balance in the short run more strongly through price than output changes. In a globalised world, these changes in agricultural prices trigger international trade flows exploiting arbitrage opportunities and thereby mitigating the price changes.

Hence, quantitative assessment of policies intending to limit the risks of such shocks for farmers' incomes necessitates a model which comprehensively accounts for the feedback effects between product markets, between product and factor markets, and between EU domestic and international markets. Quantifying and comparing the effectiveness and efficiency of these safety net policies necessitates an empirical modelling framework. This study further extends and applies a global CGE model to facilitate the impact assessment of different safety net policy instruments on stabilizing farm incomes and the associated budget costs while accounting for interlinkages within the agricultural sector as well as with manufacturing and service sectors, and with markets in other countries and repercussion effects.

Using this framework and the variation in historic annual yields as observed since 1961 as a test bed, we simulate the current BPS policy and the three proposed safety net policies to address the following research questions: To what extent do the safety net instruments protect from downside risks and stabilize agricultural incomes? How well are the payments targeted? What share of the CAP's budget is required to fund these flexible payments? How budget-efficient are the instruments in protecting from downside risks? How do these policies perform compared to the current direct payments policy? To what extent are the policies redistributing CAP payments among MS?

Although earlier studies have utilized CGE models for detailed assessments of the impacts of various CAP policies, for example, Boulanger and Philippidis (2015), Boysen et al. (2016), Nowicki et al. (2009) and Urban et al. (2016), to the best of our knowledge, safety net instruments have not been analysed before with CGE models. CGE studies that come closest to examining the issues in this paper include, e.g., intervention prices (Walsh et al., 2007), stockholding under consideration of market volatility based on exogenous supply shocks (Femenia, 2010; Hertel et al., 2005), or subsidized insurance programs considering risk sharing (Gohin, 2019).

The remainder of the article is organized as follows. Section 2 describes the experimental design, data, modelling framework and scenarios. Section 3 presents the results. Finally, Section 4 synthesises the outcomes and draws conclusions.

2 Method

We use a global CGE model framework to assess the effects of the current BPS and the three safety net policies across a series of historic annual yield shocks in comparison to a synthetic base year. Section 2.1 introduces the estimation of agricultural yield trends and shocks from historic agricultural data, followed by the presentation of the extended CGE modelling framework that incorporates the new safety net policy instruments in Section 2.2. For the construction of the synthetic base year, first the initial database is updated to the year 2020 to account for economic and CAP changes in Section 2.3. Then, the updated database is used to simulate an "average" year 2020 where yields in all agricultural sectors and countries are average, i.e., on the trend line. Finally, Section 2.4 gives a brief overview of the policy scenarios.

2.1 Estimation of yield trends and shocks

The observed variability in yields of arable crops and livestock over the period 1961 to 2011 serves as basis for the assessment of the safety net instruments. After deriving yield data from FAO production statistics (FAOSTAT, 2018), we isolate using regression general productivity trends determined by technological progress, production systems and climate from yield fluctuations caused by severe weather events, disasters and other unexpected events. The result is a dataset which retains only the annual deviations of the yield from its trend for 51 years. This is done for 10 product groups for 25 EU MS or regions plus an aggregate for the rest of the world (ROW), see Figure 1 for the list, which are chosen to align with the primary crop and livestock product groups and regions represented in the CGE model used. The approach followed is explained in the Supplementary Information A.

Figure 1 shows the distribution of yield shocks. Both diagrams depict for the yield deviations from the trend – indicated by increasing darkness of the colour – the minimum and maximum value, the 5 to 95% interquantile range (IQNR), the 25 to 75% interquartile range (IQR) and the median. The left-hand panel summarizes the variability over time and regions for products, i.e., 51×26 data points per crop, whereas the right-hand diagram shows the variability over time and products for regions, i.e. 51×10 data points per region.

While the middle 50% of the estimated yield deviations (IQR) for most of the arable crops in the left diagram lie between $\pm$8%, the range for 90% of the estimates (IQNR) increases to $\pm$25%. The 10% most extreme deviations are especially high for oilseeds ($\pm$90%) and other grains ($\pm$87%) while they are substantially lower for the other crops. The variabilities of livestock and vegetables and fruits yields tend to be the lowest. This might be expected as these are products which farmers often produce under more strongly controlled conditions.

The differences in yield variability between regions are illustrated in the right-hand panel. The extent of the IQNR and extremes clearly show that some countries, such as Cyprus, Malta or Latvia, are exposed to much stronger yield losses than other countries, such as Ireland or the Netherlands. Note that averaging yield variability across larger regions or product groups naturally decreases the variability compared to smaller ones.

Estimated annual yield deviations for a product tend to show the strongest positive correlation between directly neighbouring MS and weaker positive correlation with more distant neighbours, see Supplementary Information B for details. For example, wheat yield deviations in Lithuania are strongly positively and statistically significantly (5% level) correlated with those in Estonia and Latvia and less strongly with Poland. Weak positive correlations with Czechia, Austria, Bulgaria, Denmark, France, Hungary, Slovakia, and Sweden are not statistically significant. Fewer positive correlations between MS are displayed for livestock, raw milk and especially

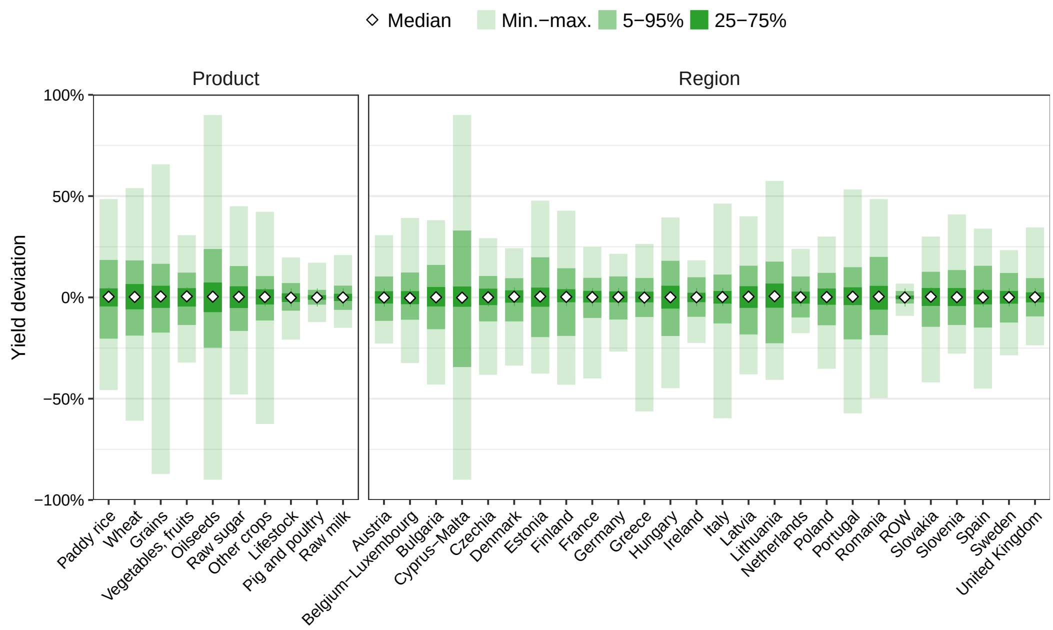

Figure 1: Yield variability. Source: Authors' elaboration.

pig and poultry than for crops.

2.2 CGE model

Our model for the analysis of the safety net policies builds on version 6 of the Global Trade Analysis Project (GTAP) model. GTAP is a comparative-static, multi-regional CGE model and is well documented in Hertel (1997). In the standard GTAP model, the various agricultural policy instruments related to domestic support (budgetary transfers) are bunched together in only five price wedges: output, intermediate inputs, land, capital, and labour. Market price support is implicitly included in border measures.

As agricultural domestic support is at the centre of this study, we further extend the version of the GTAP model by Urban et al. (2014, 2016) which amends the GTAP modelling framework by a more detailed representation of the CAP measures. These measures are incorporated in this model approach considering the structure of support: Pillar 1 instruments (e.g., market measures, decoupled and coupled payments) and Pillar 2 instruments (e.g., investments in physical capital and human capacity, least favoured area payments, agri-environmental measures) as well as national payments. First, these payments are linked to the most appropriate price wedge. Second, these additional policy instruments subdivide the existing five price wedges further taking account of the production requirements and thus the effect on farm level output decisions of the different CAP measures based on four different payment categories according to the Producer Support Estimate

(PSE OECD, 2016) concept of the OECD: product specific transfers (SCT), group specific transfers (GCT), all commodity transfers (ACT) and other transfer to producers. In this way, the extended model better represents the underlying value flows and price linkage equations that determine the extent to which CAP measures affect farmers' decisions and stimulate production.

Due to the short-run year-to-year nature of the present analysis, our version of the model distributes all BPS payments both MS- and sector-specific at a homogenous rate across the production factors land, labour and capital. The share of the BPS payments of each sector and MS in the total of the EU BPS budget is kept constant. This mimics that these payments are already programmed in the year in which the yield shock occurs so that the subsidy amount paid remains in that sector. The homogenous distribution across factors tries to minimise changing incentives between factors.[4]

We further extend the model by three new policy instruments serving to protect agricultural sectors in the case of price (PLC), revenue (ARC) or income losses (IST). The integration of these safety net instruments is achieved by further splitting the price linkage equations to include additional tax wedges. In contrast to the existing policy instruments, each safety net instrument is triggered by a specific condition based on a lower bound on price, revenue or income, respectively: These trigger mechanisms are modelled as complementarity conditions. Table 1 summarises these conditions and the calculation of the corresponding subsidy rates for the three policy instruments.

Table 1: Safety net policy mechanisms

Policy instrument	Trigger condition	Subsidy rate
PLC	$P_M < P_R$	$TF_{PLC} = \frac{0.85 \times (P_R - P_M) \times 0.9 \times Q_0}{VFMT}$
ARC	$REV_A < REV_R$	$TF_{ARC} = \frac{0.85 \times (REV_R - REV_A) \times Area_0}{VFMT}$
IST	$INC_A < INC_R$	$TF_{IST} = \frac{0.7 \times (INC_R - INC_A)}{VFMT}$

Source: Authors' elaboration. P_M, P_R: market and reference price, $TF_{PLC}, TF_{ARC}, TF_{IST}$: PLC, ARC and IST instruments, QO_0: base output quantity, $Area_0, Area$: base and actual area, $VFMT$: value added (including factor taxes) excluding safety net, REV_A, REV_R: actual and reference revenue per hectare, INC_A, INC_R: actual and reference income, respectively.

All safety net policies are sector- and MS-specific. PLC is activated if the market price P_M in some sector and region falls below the reference price P_R assumed 90% of the base year P_M. Then, the sector receives a deficiency payment equal to 85% of the price difference ($P_R - P_M$) multiplied by 90% of the yield times the

[4]For a recent overview on ways to model EU decoupled payments, see Boulanger et al. (2017).

area as given in the synthetic base year (see Section 2.3). ARC triggers a payment of 85% of the difference between reference (REV_R) and actual (REV_A) sector revenue multiplied by the base revenue if REV_A falls below REV_R. REV_R is 86% of the base revenue. Under IST, 70% of the difference between reference INC_R and actual income INC_A is paid if INC_A falls below INC_R. INC_R is 80% of the base year income.

These parameter values are taken from the 2014 US Farm Bill for PLC and ARC and the 2014–2020 CAP amended by the Omnibus Agricultural Provisions Regulation (EU) 2393/2017 for IST. Note that in the US Farm Bill and the CAP, reference values are based on three or five-year simple or Olympic averages or historic values for prices, yields and areas to avoid creating production incentives. Hence, these payments are partially decoupled from farmers' output decisions.

The subsidy rate $TF(j, r)$ for the respective policy is implemented as an additional *ad valorem* subsidy distributing the payout value homogenously across the value of factors employed (excluding "natural resources") in sector j in region r, thereby increasing the wedge between market and agent's price. To facilitate the redistribution of the CAP budget between MS by the safety net policies, the total EU CAP budget itself has been endogenized in the model. For financing, MS transfer 80% of their collected import tariff revenue into the CAP budget (European Commission, 2018). The remaining gap in the CAP budget is filled by all MS contributing an equal percentage of their GDP. This CAP budget is then allocated to finance the different payment types (BPS, SCT, ACT, GCT). Like the current crisis reserve, our safety net policies are directly funded out of the total EU BPS envelope and all MS contribute an equal percentage share of their individual BPS receipts. All non-BPS payments of each MS are unaffected by the safety net policies. Thus, each MS receives a constant share of the total CAP budget minus the solidarity contributions to the safety net plus potential payouts from the safety net.

Considering the one-year, short-term nature of the simulations, the model closures are specified to keep land, capital, and natural resources fixed in the respective sectors[5] while labour can freely move between sectors. This short-run closure in combination with the homogenous distribution of the BPS according to factors of production, leads to only mild production incentives from the sector-specific safety net subsidies (or from the BPS itself) and to only moderate factor movements between sectors.

2.3 Database update

Version 9.2 year 2011 of the GTAP database (Aguiar et al., 2016) serves as starting point for the quantitative analysis. The 140 countries and regions and 57 sectors

[5]Technically, these factors are sluggish with a Constant Elasticity of Transformation elasticity of -0.001.

are aggregated to a 26 region and 22 sector database. This aggregation considers 25 EU MS of which Belgium and Luxembourg as well as Cyprus and Malta are aggregated plus the UK, which in the experiments is treated as an EU MS. Due to a lack of domestic support data for Croatia, Croatia is included in the aggregate of countries for the Rest of the World (ROW). The database keeps all primary agricultural commodities (12) and processed food (8) sectors as disaggregated as possible while the remaining sectors are aggregated to "manufacturing" and "services", respectively. Note that only 10 primary agricultural commodities are included in the yield deviations database because the data for the remaining two (plant-based fibres and wool) was insufficient.

To incorporate the additional data detail of the CAP measures required by the extended GTAP model into the standard GTAP database, a complex update procedure based on the Altertax program (Malcolm, 1998) and data from the Producer Support Estimate (PSE) database of the OECD (2020) and the EU Clearance Audit Trail System (CATS) database provided by Boulanger et al. (2016) is used.

The initial database, reflecting the year 2011, is updated to account for changes in the economic and political framework. The macroeconomic environment is updated to 2020 based on projections for GDP, population, and factor endowments taken from Fouré et al. (2013). At the same time, the changes in the structure and budget of the CAP based on the policy reforms 2007 to 2013 and 2014 to 2020 are updated utilizing European Agricultural Guarantee Fund (EAGF) and European Agricultural Fund for Rural Development (EAFRD) financial reports and the multiannual financial framework (MFF) for the period 2014 to 2020 as well as data provided by Boulanger et al. (2016) for the year 2014. According to the MFF, the CAP budget spent on Pillars 1 and 2 is reduced by 13% and 18% in nominal terms, respectively (Little et al., 2013). In addition, coupled payments, e.g., for seeds, beef and veal and protein crops, are decoupled in 2012 and shifted into the BPS. Payments are (partially) re-coupled to production according to Article 68 VO (EC) No. 73, 2009.

This GTAP database updated to 2020 is still based on the yields which occurred in 2011. To transform it into one where all yields in all MS and sectors are aligned with their respective trend lines, we conduct a pre-simulation. For this purpose, the factor input efficiency of each product group in each region is shocked by the reciprocal value of its yield deviation in 2011, see Section 2.1. This synthetic base "year" serves as the starting point and reference for all the simulations which will be introduce in the next section.

2.4 Scenario overview

The income risk-reducing effects of the current BPS and the safety net policies are assessed by simulating the BPS, PLC, ARC and IST model versions each with all of the 51 historic annual yield deviation scenarios. The policies' parameters are set as outlined in Table 1. All years are simulated independently from one another. One year of yield deviation is introduced to the CGE model as percentage change shocks to the factor input efficiency parameters of the production function of each product group and region individually. Applying a set of estimated yield deviations of an actual year together ensures that the real-world, observed correlation of the variability across products and regions is maintained.

3 Results

We first discuss the results of the current policy of the BPS which then serves as the reference for comparison with the alternative safety net policy scenarios in the following section.

3.1 Base scenario results

Starting from the synthetic base year that represents the economy in the year 2020 and where yields all match their respective trends, we simulate 51 yield scenarios corresponding to the estimated yield deviations for the years 1961 to 2011. Due to the abundance of results, it is necessary to focus the discussion on the main objective, i.e., the reduction of income risks, in particular, the extreme downside risk and the related budget effects. The occurrence of high yield losses in the extremes and differences in the extent of yield variability between regions and sectors has been illustrated in Section 2.1.

Figure 2 shows the simulated income changes across the 51 annual yield scenarios for the *status quo* BPS policy. The statistics are presented in the same way as discussed in context with Figure 1. They are calculated based on the percentage income changes compared to the synthetic base year, under the assumption that each agricultural sector in each region represents an individual entity, whose "income risk" is the target of the policies, and that all of these entities are all treated equally (democratically) in achieving the goal, i.e., not giving larger weight to larger entities .

The left-hand panel shows the distribution of income changes of a sector across all regions and yield scenarios, whereas the right-hand panel shows the changes of a region across all sectors and yield scenarios. In comparison to the underlying yield shocks presented in Figure 1, the IQR and IQNR bars for income tend to show larger variation than their yield counterparts, especially on the positive side.[6] Negative variations are larger notably for the three cereals sectors, oil seeds and raw sugar.

[6]To increase the readability of diagram, the scale of the ordinate is limited to $\pm$100%. This affects only extreme deviations on the positive side which are irrelevant for this study.

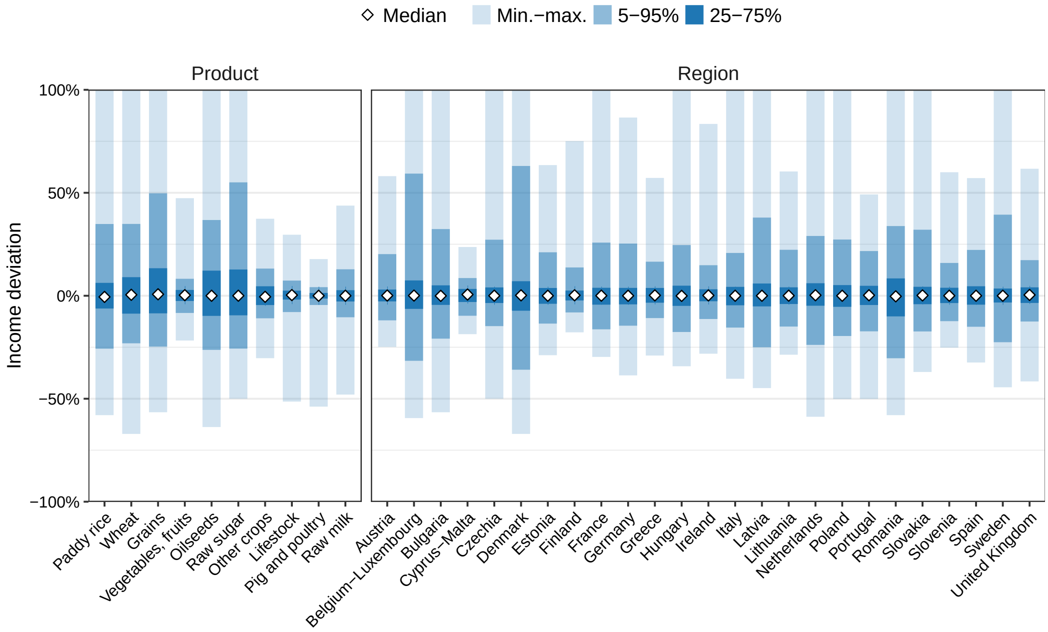

Figure 2: Income variability in the BPS scenario. Source: Authors' elaboration.

This emphasizes that the natural hedge, which offsets an output effect by a price effect in the opposite direction, is not very effective or that prices even move into the same direction. By contrast, for fruits and vegetables the observed negative income variation tends to be smaller indicating some natural hedge, though not enough to absorb the shock completely. Nevertheless, the 5% most extreme negative yield deviations, i.e., the bottom, lightly coloured parts of the bars, translate into smaller income for the most severe cases of grains, oil seeds and other crops while the opposite is true for livestock products. Note that the top end of the bottom 5% bar also represents the 5% Value at Risk (VaR). There is a 5% probability that the income loss is greater than the percentage shown.

The price effect depends on the tradability of the product and market developments in other regions of the world, particularly whether, e.g., a bad harvest is locally confined or spans multiple regions. The comparison according to regions (right-hand panel) displays negative income deviations that predominantly are similar or exceeding the corresponding yield deviations while positive deviations are largely greater. This indicates that all regions have sectors in which yield changes affect income more than proportionally.

The BPS pays each farmer a constant amount each year, thereby shifting the mean of the farmer's distribution of income across years upwards. But it does not decrease the income variability as measured by the standard deviation.[7]

[7]The BPS decreases the coefficient of variation which is defined as standard deviation divided by mean and hence directly depending on the mean.

3.2 Safety net policy simulation results

In contrast to the BPS which supports farm incomes by a guaranteed constant amount through direct payments, the safety net policies are conditional and aimed at reducing downside risks for income. As each policy instrument takes a different indicator as the basis to determine the occurrence of income risk, they differ in how effective and budget efficient they are in reducing downside risk. In the simulations, income is measured as value added after accounting for taxes and subsidies. Thus, income is determined by output price and quantity and the cost of intermediate inputs and potential taxes and subsidies.

IST directly uses income as the indicator and hence safeguards from income risks originating from both up- and downstream markets. For example, grains prices affect input cost for cattle and cattle prices affect demand for and therefore revenue from grains.

By contrast, ARC is based on product revenue per hectare and therefore considers output price and yield changes but ignores intermediate input costs. It ensures that the natural hedge effect is accounted for in determining payouts. This instrument clearly depends on the functioning of the price mechanism in a particular market. The highest payments arise for products for which output quantity and market price are only weakly correlated.

Finally, PLC is based exclusively on output prices ignoring changes in both input costs and output. Accordingly, it protects farmers in case of negative price shocks but not in case of yield reductions. Nevertheless, yield losses are typically compensated at least partly by higher prices. But a peculiar problem might arise in case of high yields which usually are associated with low prices: PLC might then provide an unjustified payment, making farmers with good harvests even better off. PLC seems beneficial for agricultural producers in markets featuring high correlation between output quantity and price and in times of low prices.

For each of the three policy scenarios, the model is simulated with each of the 51 yield scenarios. The results are discussed in comparison to the changes in the BPS scenario representing the 2014–2020 CAP policy.[8]

Table 2 shows the probabilities of a sector suffering an income loss larger than a specific percentage of its income in the base year as calculated from the 51 simulation results for each policy. It quantifies how effective the three safety net policies are in reducing the risk of income loss. The probability of some loss of income occurring under the BPS policy is 48.5%. This probability is higher for all safety net policies because all sectors are required to contribute some of their direct pay-

[8] Because of numerical issues in simulations with extremely small sectors, 28 region–sectors pairs with an incomes of less than 15 million US Dollars (mainly paddy rice and sugar beet) have been excluded from the safety net policies and also do not contribute to the payments for those policies.

Table 2: Simulated relative frequency of a sector suffering an income loss larger than X% compared to the base year

	Probability of income loss greater than							
Policy	0%	10%	20%	30%	40%	50%	60%	70%
BPS	48.47	12.41	3.90	1.45	0.62	0.19	0.02	0.00
IST	49.28	12.60	4.08	0.46	0.00	0.00	0.00	0.00
ARC	49.03	11.77	3.29	1.05	0.37	0.10	0.00	0.00
PLC	49.96	12.10	3.54	1.31	0.49	0.15	0.03	0.00

Source: Own computation from simulation results.

ments to finance the payout for the occurrence of a risk event elsewhere. ARC and PLC policies reduce the risk for a loss greater than 10% and greater than 20% compared to BPS, but IST increases it due to its trigger which is activated by income losses greater than 20%. For losses greater than 30% and beyond, the ordering remains constant: the three alternatives reduce the risk compared to BPS with IST reducing it the most and ARC second most while PLC comes third. IST decreases the probability of losing more than 30% of income by 68% compared to BPS and of losing more than 40% to zero in contrast to ARC which reaches zero for losses of over 60% and BPS and PLC only for losses of over 70%.

As the costs of the three policies also differ in terms of the share of the CAP budget required for the safety net, the effectiveness of the policies with respect to risk reduction needs to be considered in light of the associated costs. Table 3 contrasts the CAP budget costs with the outcome in terms of three risk measures as means over the 51 years.

Table 3: Percentage of CAP budget spent on safety net and three measures of risk averaged over all years

Policy	% triggered	% CAP budget	Semi-SD	5% VaR	$P(\text{loss} > 30\%)$
BPS	0.00	0.00	7.49	-16.23	1.45
IST	4.07	0.39	6.71	-15.69	0.46
ARC	3.32	0.41	6.89	-14.91	1.05
PLC	4.22	0.94	7.27	-15.63	1.31

Source: Own computation from simulation results.

Column *% triggered* summarises the share of the 11,322 region-sector-year triples in which the safety net is activated. The magnitude is similar for all three policies with ARC activated in the least cases. Column *% CAP budget* reports the mean CAP budget spent on the respective safety net policy as a share of the total CAP budget for the BPS policy. The semi-standard deviation of the income, presented in column *semi-SD*, is similar to the standard deviation but only considers negative deviations from the mean.[9] The *5% VaR* column says that, on average, there is a 5% probability that the income falls by more than the percentage value shown. Column $P(\mathit{loss} > 30\%)$ presents the mean probability that income drops by more than 30% as calculated from the simulation results.

The table shows that the PLC policy is not only rather ineffective in improving the income risk over the risk of the BPS policy but also is very budget-inefficient as it requires the highest share of the CAP budget of the three safety net policies. IST and ARC have similar costs, and none is univocally superior across all three risk measures. Larger improvements in the semi-SD and the probability of income losses of greater than 30% are achieved by IST and in the 5% VaR by ARC.

As these averages hide the large variation in the results, Figure 3 shows the distribution of the CAP budget share spent on the safety net per year and plots the results in terms of the risk measures against the CAP budget share for each year. Each point in the diagrams represents one yield year scenario and summarises the income changes for all 10 agricultural sectors in all 24 EU regions and the UK. Thus, there are 51 data points for each policy. Note that all sectors are treated equally but naturally it takes less CAP budget share to decrease the income risk of a smaller sector.

The distribution of the percentage of the CAP budget spent on the safety net of each policy displayed as boxplots in panel (a) emphasises that the spending on ARC and IST policies is rather similar and by far less than on PLC. The budget costs related to IST amount to 0.2% of the total CAP budget in the median but might go up to 2.2% to cover the most extreme case. ARC's budget costs stay below 1.9% (median 0.18%) and tend to reduce the variance less than IST but clearly more than PLC (median 0.47%). PLC requires 7.7% of the CAP budget in the extreme.

Panel (b) shows the effect on the semi-SD. This is measured as the change of the semi-SD as a percentage of the semi-SD in the corresponding BPS scenario. The plot highlights that IST reduces negative income variation in a more targeted way than ARC as there is a more pronounced association between budget cost and semi-SD change. PLC appears rather ineffective here with costs being unrelated to semi-SD reduction and potentially the highest budget costs of up to 7.7% of the CAP budget. Panel (b) indicates an ordering of the three policies in terms of their efficiency in decreasing negative income variation of IST over ARC over PLC.

Panel (c) illustrates the changes in the 5% VaR, more specifically, by how many points the percentage income loss is changed. None of the three instruments shows a strong correlation between budget expenses and improvement of the VaR. Nevertheless, in tendency, ARC appears more efficient than IST and PLC which both

[9] Specifically, the semi-SD is calculated as the SD after setting all positive income deviations to zero.

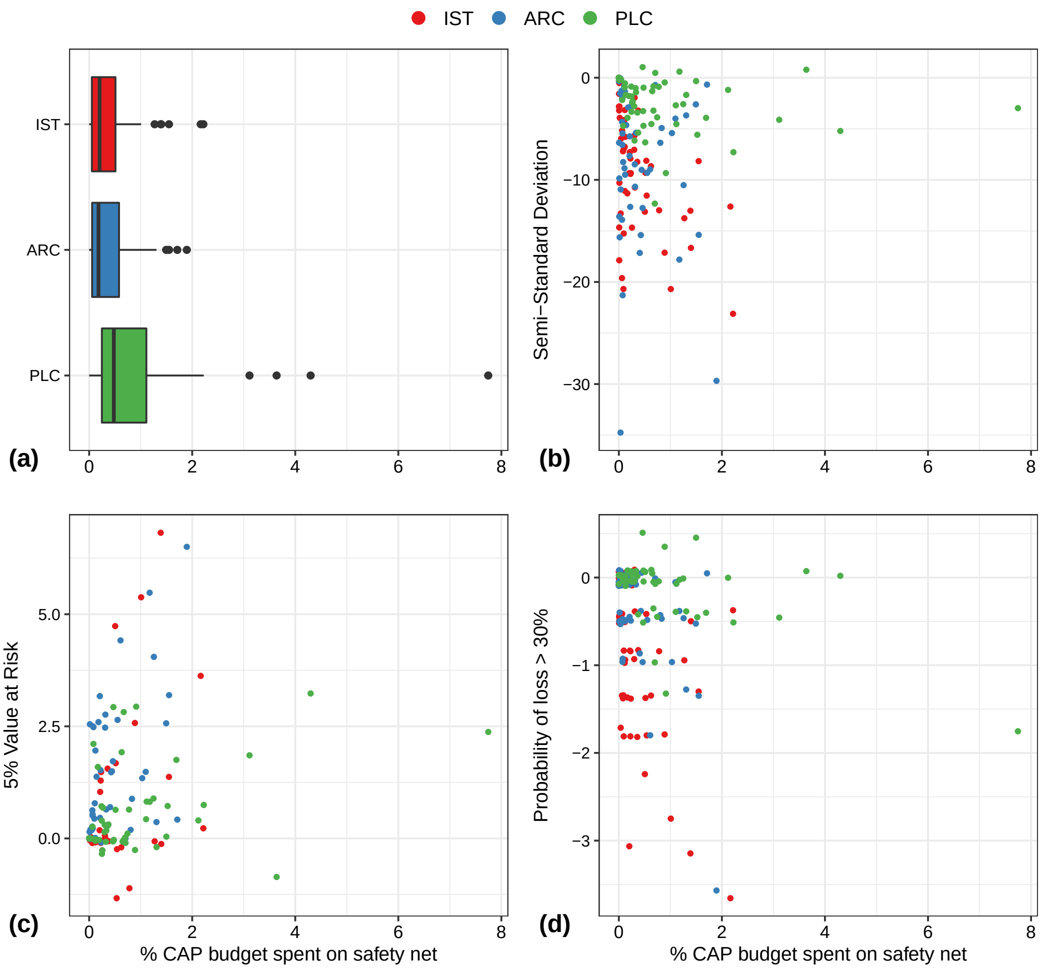

Figure 3: Budget efficiency. Difference in risk measures in comparison to the BPS policy contrasted with safety net CAP budget costs. Semi-standard deviation is given as percentage difference from the BPS result. The other y-axis measures are shown as percentage point difference to the BPS scenario. Source: Authors' elaboration.

even might worsen the 5% VaR. PLC again displays the least targeting.

Panel (d) measures the change in the probability of an income loss of 30% or more compared to the BPS scenario in percentage points. Here, unsurprisingly IST shows a clearly higher efficiency than the other two policies. ARC is more often leading to greater improvements at similar budget expenses compared to PLC. Hence, according to this measure a clear ordering of the three policies also emerges.

Figure 4 shows what percentage of each Euro paid into the respective safety net policy is used to cover specific ranges of percentage income losses. For example, for a sector with an income loss of 50% that receives a safety net payout reducing the loss to 35%, a contribution of 10% of its income to the 40% to 50% and of 5% to the 30% to 40% range is counted. The plot clarifies how efficiently the payments are targeted at various loss ranges. As the safety net policies differ strongly in their total costs, here the percentage of those total costs is used to enable an objective comparison in terms of transfer efficiency.

The largest shares of ARC and PLC payouts, 64% and 62%, respectively, are used to cover incomes losses of less than 20%. By contrast, IST covers only losses of at least 20%. In general, ARC and particularly PLC are covering much shallower losses than IST and allocate only small shares (12.8% and 14.2%) to deep losses of greater than 30% whereas IST allocates 66.1% to those. This reveals a clear disadvantage of the ARC and PLC mechanisms if the policy objective is the mitigation of catastrophic, deep income losses. Moreover, as indicated by the bars in the losses less than zero-category, ARC and PLC payouts are higher than the losses in some cases.

Figure 5 summarises how the policies affect countries' total receipts from the CAP, in terms of mean and median percentage changes in relation to the BPS scenario per year for each policy. The fact that the medians represented by diamonds are mostly closer to zero than the means represented by bar heights indicates some presence of extreme payments or receipts. According to the simulation results, most countries become net contributors to the safety net policy and pay an average of up to 1.2% of their total CAP budget and 0.7% or less in the median, depending on the policy. In most cases this is less than 0.5%. Corresponding to the high overall CAP budget cost of PLC, contributors' average payments are more marked than for IST and ARC. Romania is the only country which prominently gains under all three policies gaining between 2% and 11% on top of its baseline CAP budget on average. But in the median, these gains are only between 0% and 1.9% illustrat-

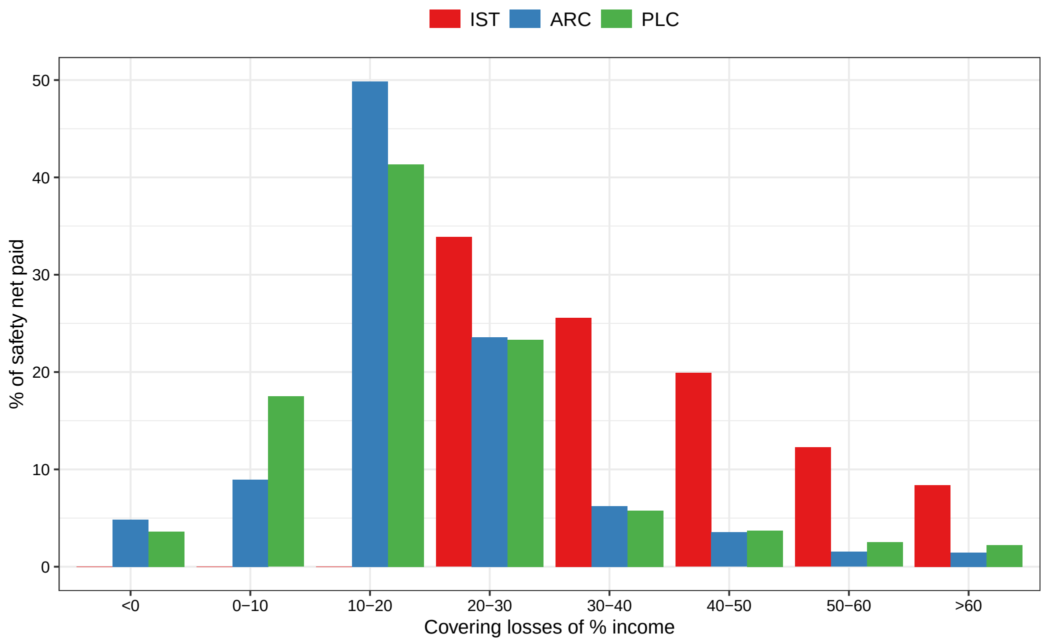

Figure 4: Transfer efficiency. What share of each Euro paid to the safety net policy covers income losses within ranges. Source: Authors' elaboration.

ing the large variation in the safety net receipts. Romania is indeed an exception as it is subject to large, frequent, and often multiple simultaneous negative yield shocks resulting in strong price reactions across agricultural products. This leads to strong input price shocks but also to large gains in other years. Other net beneficiaries receiving over 0.5% on average in addition are: under IST Denmark, under ARC Bulgaria, Estonia, Latvia, and Lithuania, and under PLC Portugal. Note that while countries all contribute the same share of their BPS receipts, the BPS receipts as a share of a country's total CAP receipts can differ substantially between countries, contributing to the differences shown in the diagram.

Thus, all three policies lead to CAP budget redistribution between the MS to some extent with a mean annual transfer into the safety net for IST, ARC and PLC of 0.39%, 0.41% and 0.94% of the total CAP budget (see Table 2), respectively, and 0.20%, 0.18% and 0.48% in the median. It is worth noting the occasional occurrence of annual contributions of 1% to around 2% for IST and ARC and of up to 4.2% and even 7.7% in the outlier for PLC, as shown in Figure 3, panel (a).

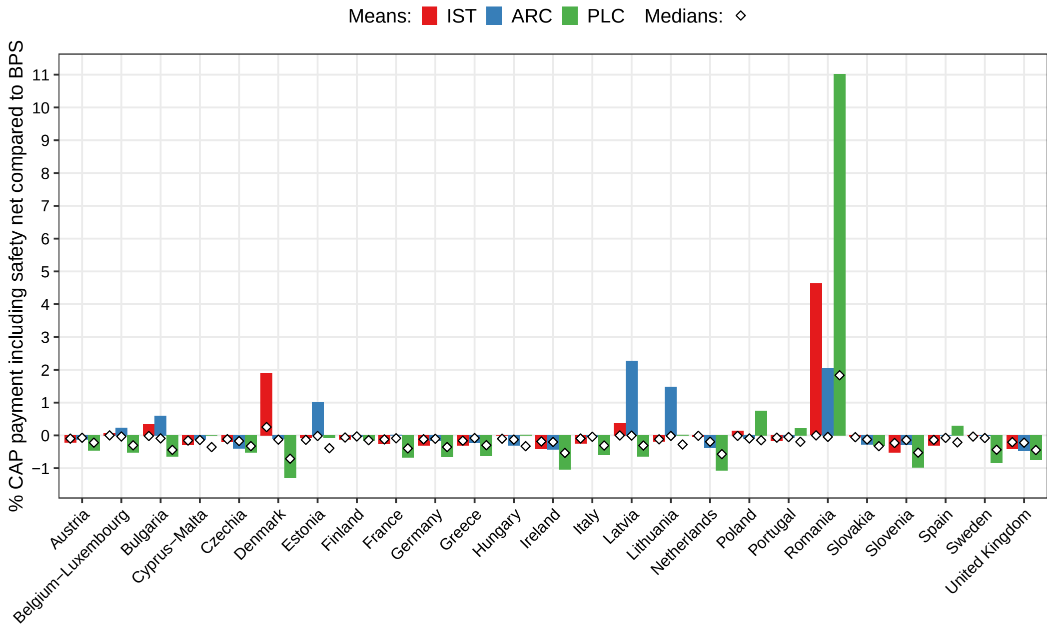

Figure 5: Average percentage change in region's CAP receipt per year for each policy as a percentage of the budget in the BPS scenario. Source: Authors' elaboration.

4 Discussion and Conclusions

Volatility of crop and livestock yields is expected to increase with climate change and the associated extreme weather events which are predicted to occur with higher frequency and stronger severity than in the past. Correspondingly, risks for agricultural incomes and food security are also growing. While the EU CAP already includes adaptation and mitigation of climate change as specific objectives (Jacobs et al., 2019), discussion and quantitative assessments of public policy options to protect farmers from the increased risk of extreme income losses caused by catastrophic weather events are lacking.

This is where the present study contributes. It assesses three policy options, fully funded through the CAP budget by taking funds out of the BPS envelope, to protect MS sectors and thereby their farmers from extreme income losses caused by yield variations at home and/or abroad. These safety net mechanisms provide EU MS extra fiscal space to safeguard their farmers in afflicted sectors from such losses. They provide farmers with a more level playing field as regards to protection from catastrophic events which currently are handled very differently from MS to MS and from event to event. The policies are implemented as social solidarity insurances where all MS and agricultural sectors contribute an equal share of their BPS payments and benefit from equal protection against extreme income risks. To identify catastrophic events which affect most of a country's sector, the entity insured is explicitly chosen as the entire sector of a MS. Once the safety net has been activated, the MS national government is responsible for identifying farmers in need and to distribute the payout between them, although subject to specific criteria to identify beneficiaries that should be set out in CAP legislation. This acknowledges the principle of subsidiarity in that regional authorities have better means to determine the needs of the individual farmers than those at the European Commission level. To ensure acceptance of the policy among stakeholders, the payout mechanisms presented fulfil the requirements of being rule-based, fair and transparent, which is a major difference to the operation of the current crisis reserve.

A major obstacle is the identification of an objective, targeted and easily monitorable index as the basis for the mechanism (Cordier and Santeramo, 2020). For the safety net policies put forward, we borrow payout trigger and calculation rules from the PLC, ARC and IST policies which recently have been applied in either US or EU agricultural policies. These are based on price, revenue, and income, respectively, and differ by triggering threshold and payout calculation. But in contrast to these current US or EU policies which protect incomes of individual farms, the safety nets proposed here protect entire farming sectors of a MS from catastrophic risks. The indices required are largely available at the MS level, but generally could also be based on representative samples, e.g., by building on the established, EU-wide Farm Accountancy Data Network (FADN) to collect up-to-date information on sectoral farm incomes. As noted by Cordier (2015), use of index-based proxies for income losses could also serve to expedite payouts and reduce management costs.

The safety net policies are assessed by simulating a set of historically observed annual yield variations, which preserve real-world correlation of yield shocks across countries and products. The global CGE model employed allows to comprehensively account for the effects on domestic and international product and factor markets and eventually on incomes, which ultimately are the focus of these policies. Importantly, the model also includes mechanisms to adapt MS CAP budget contributions and receipts which account for the implicit reallocation of CAP budget between MS due to the safety net instruments.

From the simulation results, no policy emerges as being uniquely dominant among PLC, ARC, and IST in terms of the three measures of downside risk considered. Nevertheless, IST unsurprisingly stands out as the best of these mechanisms according to most measures because it directly uses income as an index but in addition also implies rather low budget costs. However, the model does not capture that IST might also cause higher administrative costs which occur for determining and monitoring of sectoral income. This cost might counter the better targeting and lower overall budget costs in comparison to PLC and ARC. PLC might require the lowest administrative costs as it is based on observable market prices. On the downside, it is rather untargeted and implies much higher budget costs than the other two options. ARC, in turn, requires yield and area information in addition to prices which substantially increases the administrative burden. Nevertheless, it showed to be much better targeted as PLC and to incur similar low budget costs as IST.

In safeguarding deep losses, both PLC and ARC are weak, and both spend large shares of the payments on shallow income losses below 20%. At times, they also overcompensate farmers whereas IST compensations are only triggered for income losses of larger than 20%. Hence, if the policy objective is the protection from deep income losses, IST seems the only option but an additional quantitative assessment of the administrative costs of all options is necessary to allow a conclusive recommendation.

The annual budget costs for the safety net policies on average amount to between 0.4% and 0.9% of the total CAP budget and thus remain below the 400 million Euro (in 2011 prices) limit of the 2014-2020 CAP's crisis reserve. However, under the historic yield shocks, costs also reach about 2% in the extreme for ARC and IST and almost 8% for PLC. The occurrence of these extremes calls for a continuous build-up of a fund.

Finally, based on the social solidarity principle, the proposed safety net instruments would redistribute income between MS: Most countries would become net contributors with average contributions of somewhere below 0.5% of direct payments across the years for ARC and IST and below 1.2% for PLC. Differing by policy, few countries would emerge as net beneficiaries of noteworthy magnitude.

The fact that small MS (and small sectors) likely trigger safety net payouts more frequently than large, naturally more heterogenous ones, could be argued to result in an advantage for small MS. However, payouts to small MS cause only relatively small deductions of other MS BPS budgets while payouts to large MS likely imply large deductions when they occur. Moreover, in view of the ability-to-pay principle, large sectors might be in a better position to internally create measures to mitigate losses of some members than small sectors. Correspondingly, the MS-level safety net approach is in line with the spirit of a social solidarity insurance.

Ultimately, whether costs and redistribution outweigh the benefits of reduced income risks and thus greater certainty for planning investments and private life of farmers and improved food security in general is a matter of societal choice. Under the assumed reference and threshold values, only IST protects with certainty against income losses beyond 40% while much larger losses can still occur with the other two options albeit with low probability. Moreover, ARC and PLC spend large shares of their budgets on shallow losses of less than 20%. This is difficult to avoid, even by finetuning the thresholds and references, because both suffer from important defects. Using revenue and price as indices, both policies are not sensitive to income losses from increased input costs. Moreover, PLC simply ignores that the revenue effect often is smaller than the price drop when the price drop itself originates from higher yields.

Here, we explicitly evaluated only yield shocks as these are expected to occur more frequently and intensely with progressing climate change. In this setting, sectors with lower yield volatility, such as livestock and dairy, are likely to benefit less from the safety net schemes. However, this might underestimate the usefulness of the proposed tools for those sectors as they might benefit more in case of other types of shocks, which have not been included here, such as shocks on demand through pandemics or geopolitical tensions, e.g., during the COVID-19 pandemic in 2020 or the Russian embargo on EU agri-food imports in 2014, on input prices like fertilizer or energy, or due to livestock pandemics, such as the avian influenza and African swine fever.

At the same time, this implies that the results presented underestimate the potential budget burden of the safety net policies and their redistributive effects between MS. With respect to such additional shocks affecting own prices, these would increase budget shares spent on the safety nets but not affect the ranking among the tools. Nevertheless, since PLC and ARC do not capture changes in input costs, additional shocks affecting input prices, e.g., fertilizer, might increase the costs incurrent for IST relative to PLC and ARC. However, if such a shock is global or corresponding markets are efficient, the higher input costs would largely be compensated by a higher own price and thus the ranking would likely be preserved.

Another important consideration regarding the implementability of safety net policies is their compatibility with the rules of the World Trade Organization (WTO). Our PLC, ARC and IST payments are based on historical, not current, acreage. Consequently, these programmes are decoupled from production choices. Since PLC and ARC are based on price and revenue as triggers, they do not satisfy all exemption criteria to be classified as WTO Green Box support (Uruguay Round Agreement on Agriculture (URAA), Annex 2) and thus most likely would be reported as non-product-specific trade-distorting support (WTO Amber Box), see Schnepf (2019) for an overview. The IST differs from PLC and ARC as IST is triggered based on income, so that there is no direct link to price and produced quantities. However, it depends on the chosen height of the trigger, whether it fulfils the exemption criteria as outlined in Annex 2 of the URAA. The latest EU notification to the WTO for marketing year 2017/18 reports income insurances and income safety net payments equal of 359,7 million Euros as green box payments (WTO, 2020).

Nevertheless, the comparison of the maximum amount paid as safety net payment with the total value of agricultural production clearly shows that this share is far from exceeding the *de minimis* threshold of 5% (e.g., in 2017/18 = 19,759 million Euro), even considering the lower limit of 2.5% discussed in the Doha Round. Moreover, the EU's recent notification to the WTO (WTO, 2020) shows that the EU is only using a very small part of the agreed maximum trade-distorting support[10]. Thus, the development of future instruments clearly also depends on the EU's expectations about the development of future WTO negotiations.

Although the analysis of the proposed policies could be driven further by examining them under differing payout trigger and calculation parameters, we believe that the present study provides clear insights into the costs and benefits of such MS-level safety net policies and revealed characteristics of and rankings among the three alternatives which will be useful to guide future policy design and assessment.

While the motivation for this study is on policies for climate change and associated yield effects, evaluating these safety nets under other types of shocks, such as demand shocks from pandemics and geopolitical tensions, is planned for a future study.

[10]For example, marketing year's 2017/18 current Aggregate Measurement of Support equals 6,932.8 million Euro, which is accordingly very far below the committed WTO ceiling of 72,378 million Euro (WTO, 2020).

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Supplementary information

A Approach for estimation of yield trends and shocks

The following describes the estimation of the yield trends and yield deviations as used in the model simulations.

Usually, yield equals quantity produced divided by area planted for crops and production quantity divided by the number of animals for livestock. The lower product and regional detail of CGE models compared to available agricultural data generally requires aggregating to groups of products or regions. For this purpose, we determine for each product in the year 2011 a world reference price that equals the ratio of value of production measured in constant international dollars (2004 to 2006) and the production quantity. This reference price weights the 2011 reference production quantity, which is then divided by the area planted or the animal number respectively, to obtain a Laspeyres yield index for each triplet of product group, region and year. This ensures that the yield index measures only yield changes and is not influenced by composition effects caused through price or quantity changes. The resulting database covers yield indices for 25 EU MS or regions plus an aggregate for the rest of the world (ROW) and 10 product groups[1], see Section 2.3 for details.

To disentangle the general productivity trend and the general yield fluctuations, three candidate models are estimated over the period 1961 to 2011 for each of the 10 product groups and 26 regions separately using Ordinary Least Squares regression. The choice of these candidates has been guided by the goal of obtaining visually sensible fits to the data while avoiding overfitting.

$$Y_t = \beta_0 + \beta_1 t + \beta_2 P_{2t} + \beta_3 P_{3t} + \beta_4 t P_{2t} + \beta_5 t P_{3t} + \epsilon_t \quad (1)$$

$$Y_t = \beta_0 + \beta_1 t + \beta_2 t^2 + \epsilon_t \quad (2)$$

$$Y_t = \beta_0 + \beta_1 t + \beta_2 t^2 + \beta_3 t^3 + \epsilon_t \quad (3)$$

Model (1) is a piecewise-linear regression of yield index Y_t on the trend variable t with up to two structural breaks allowing intercept and slope to differ in up to three mutually different, consecutive time periods. The time period dummy variables P_{2t} and P_{3t} equal one if the country-product pair is within the respective period in year t and zero otherwise. The minimum length of a period is 10 years. The

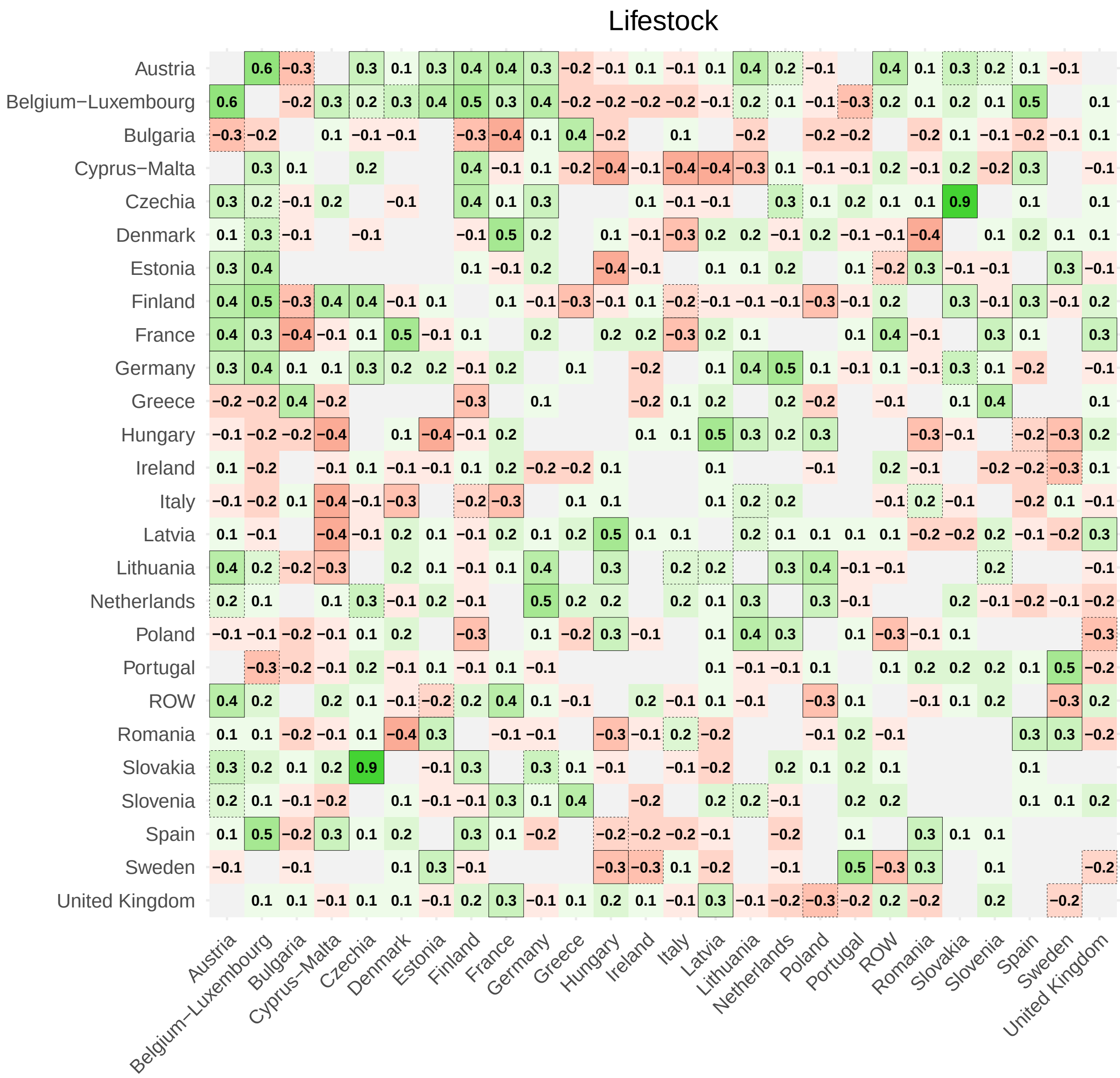
[1]"Plant based fibres'' and "wool'' are excluded due to insufficient data. Data on "other crops'' appeared implausible as FAOSTAT is missing data on some important crops, e.g., cut flowers for the Netherlands, and also shows large variation where it is implausible, e.g., strong yield variations for mushrooms. Therefore, the shock for "other crops'' is approximated by using the simple average yield shock in each country-year pair over the remaining six crops.

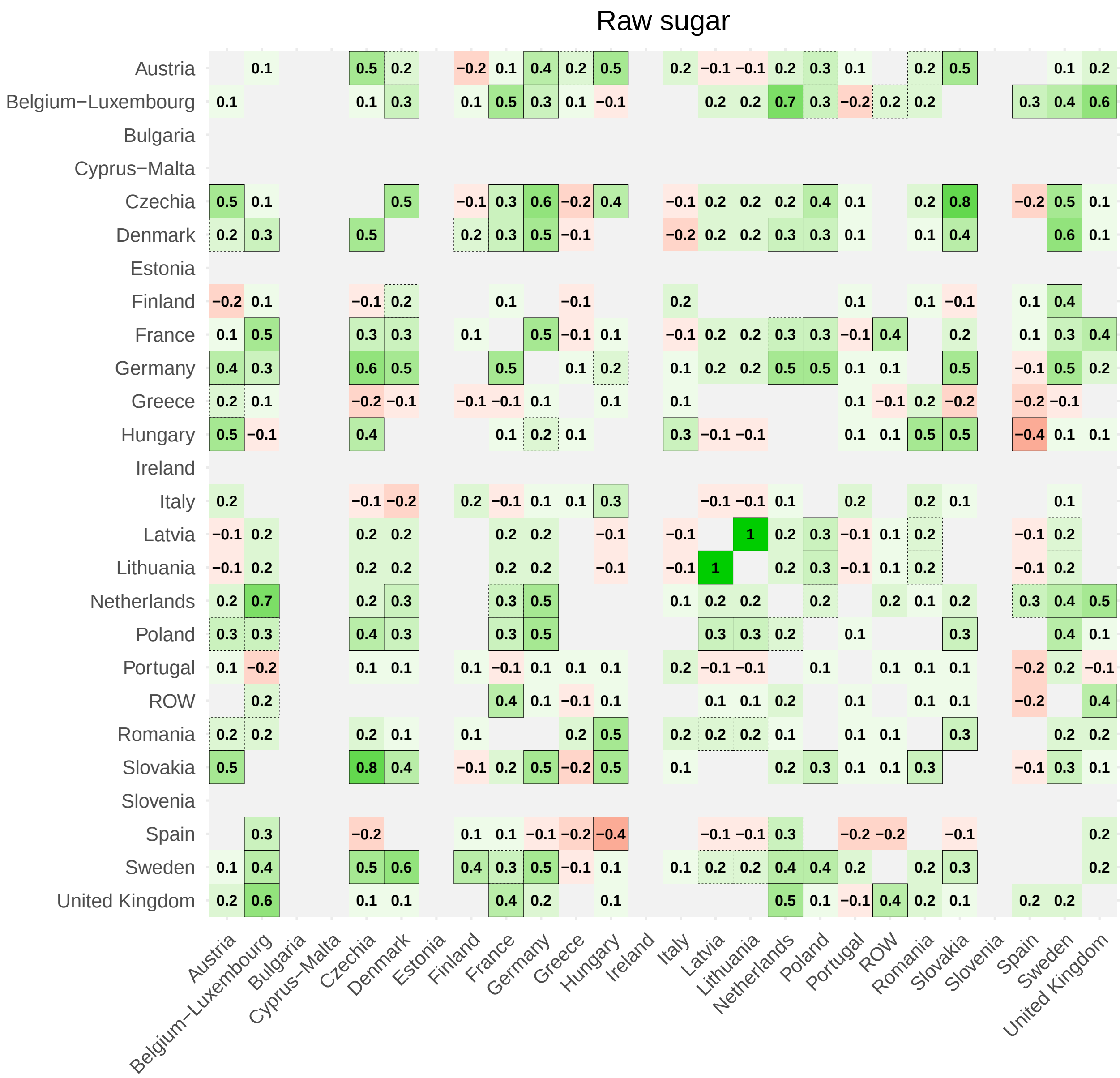
number and positions of breakpoints are statistically selected using the R package *strucchange* (Zeileis et al., 2002, 2003). Considering structural breaks is important as fundamental change of the constant and slope of the general productivity trend might have occurred, for instance, if countries split up or reunite as in the case of the Soviet Union or Germany or if statistical data collection changes. Models (2) and (3) estimate quadratic and cubic time trends, respectively.

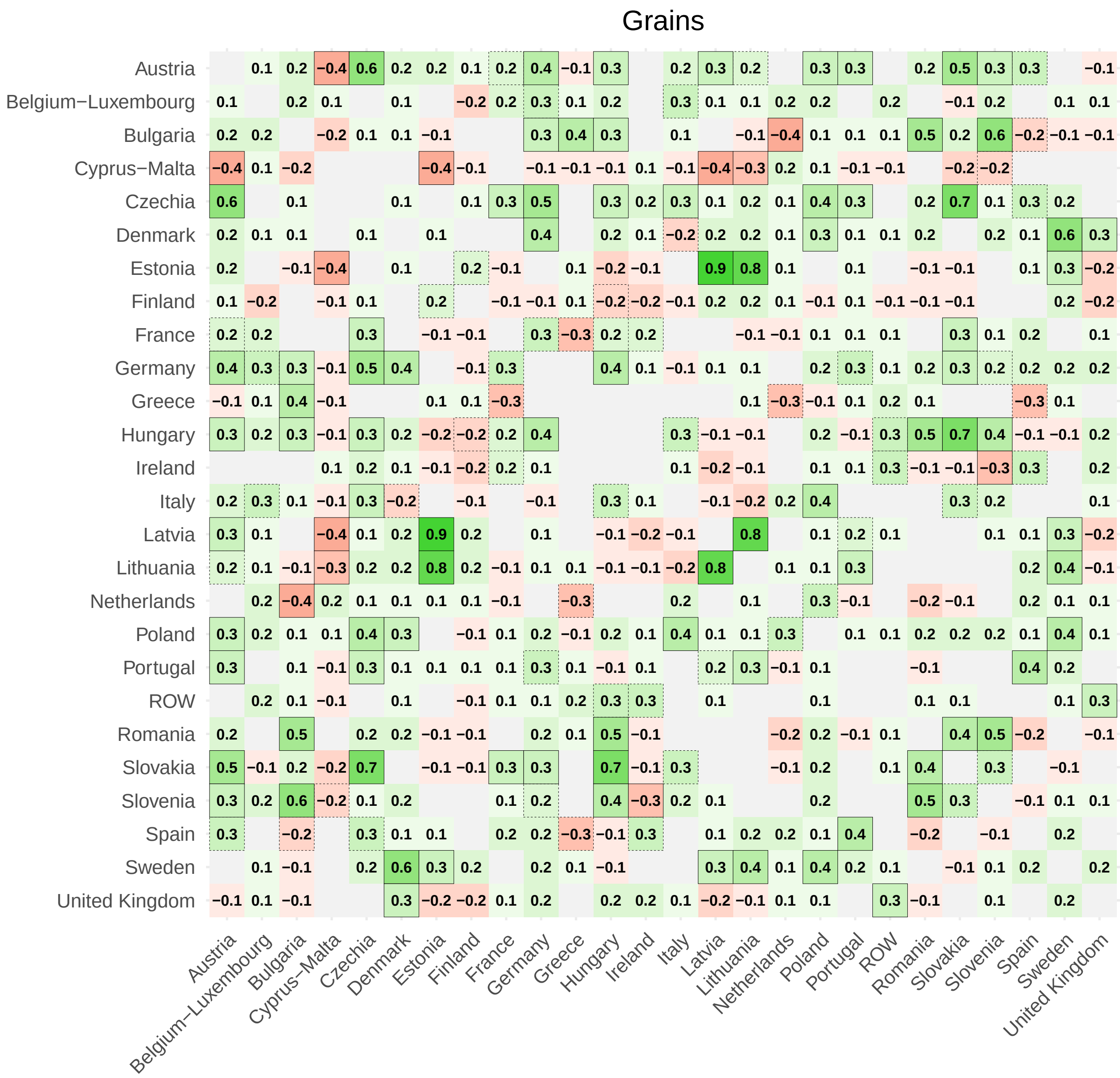
The best fitting of the three models for each country-product pair is selected according to the lowest value of Aikake information criterion value and then used for estimating the yield trend. The estimates of the error term ϵ_t represent the trend-adjusted yield distribution or "yield deviation" from the general trend that is caused by, among others, weather events, disasters, pest infestations or animal and plant diseases.

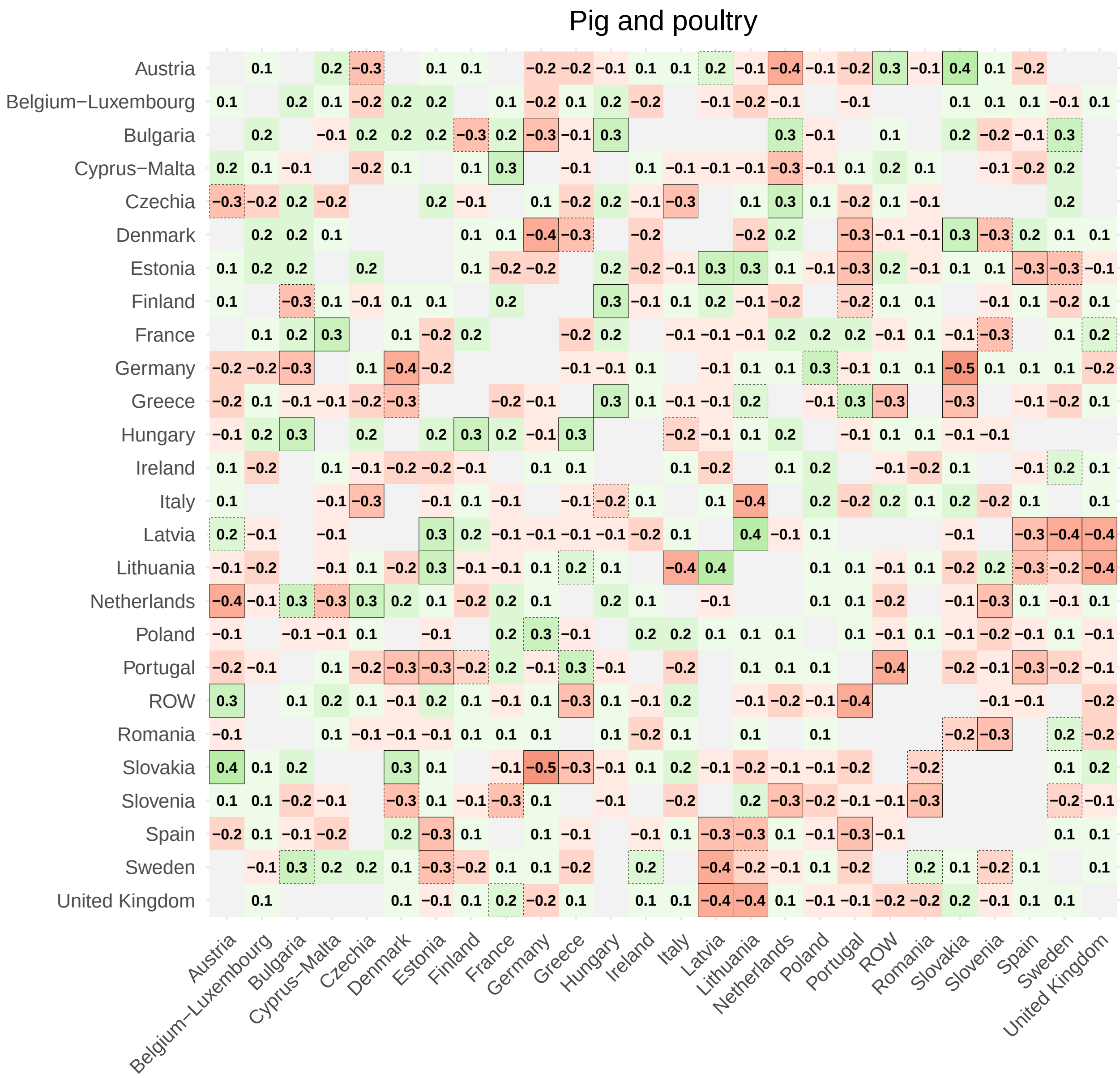
B Geographic correlation of yield deviations

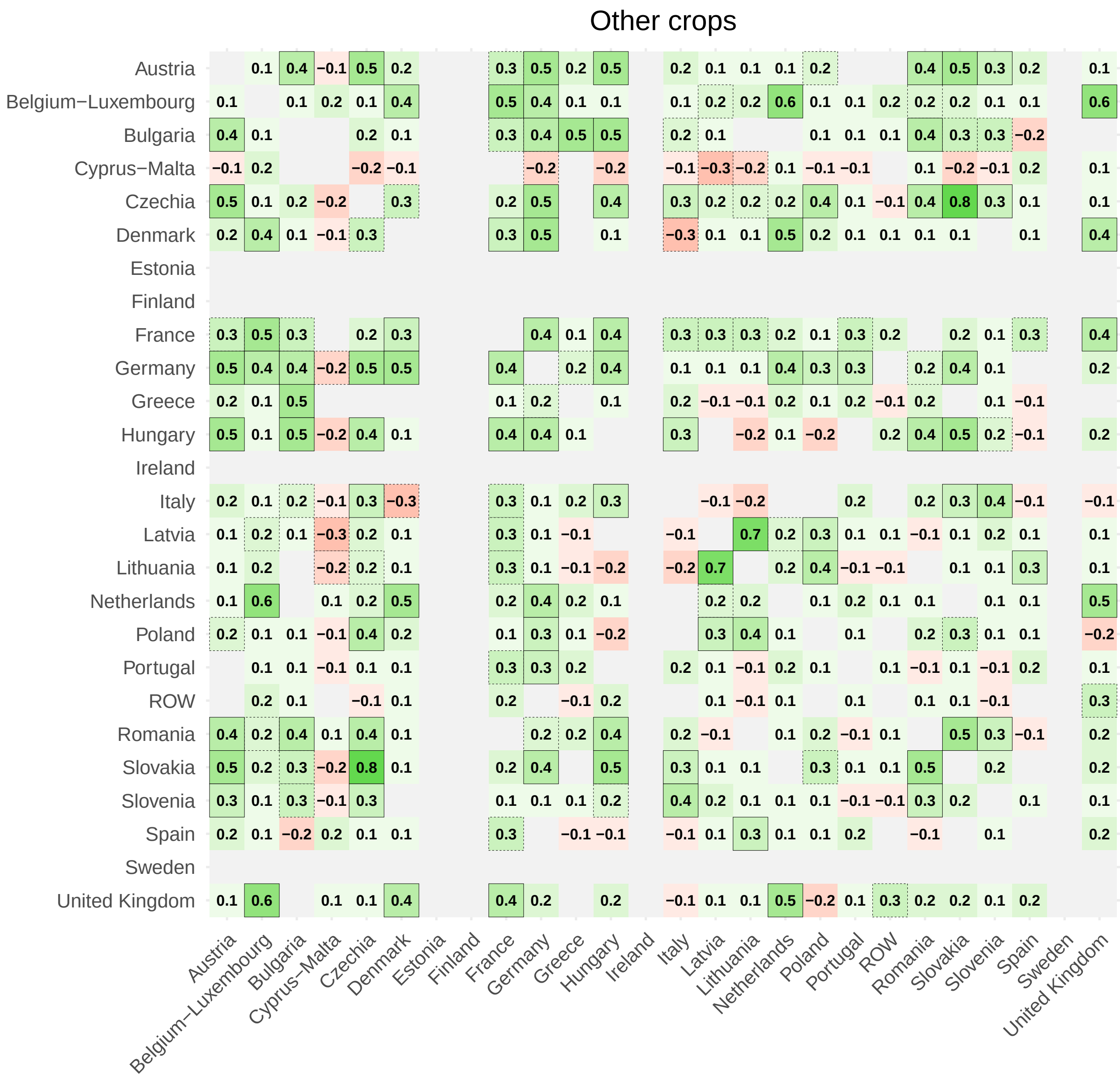
The following tables show Pearson correlation coefficients for the annual yield deviations between pairs of MS for each product group separately. Correlation coefficients significant at the 5% and 10% level are surrounded by solid and dashed black frames, respectively. Blank cells indicate that either products are not produced in either country or the correlation coefficient is less than 0.1.

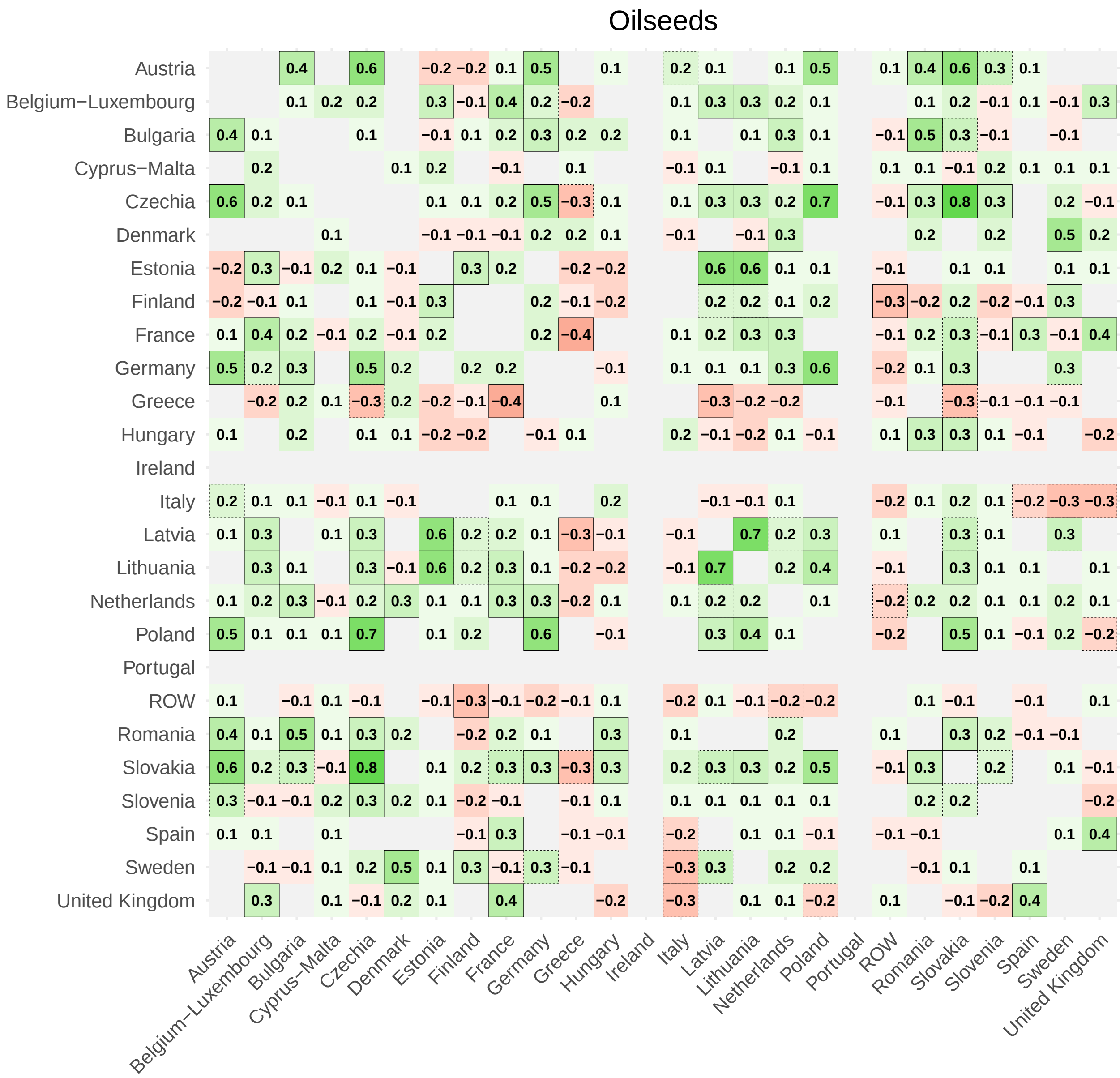

Lifestock
Austria
Belgium−Luxembourg
Bulgaria
Cyprus−Malta
Czechia
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Latvia
Lithuania
Netherlands
Poland
Portugal
ROW
Romania
Slovakia
Slovenia
Spain
Sweden
United Kingdom

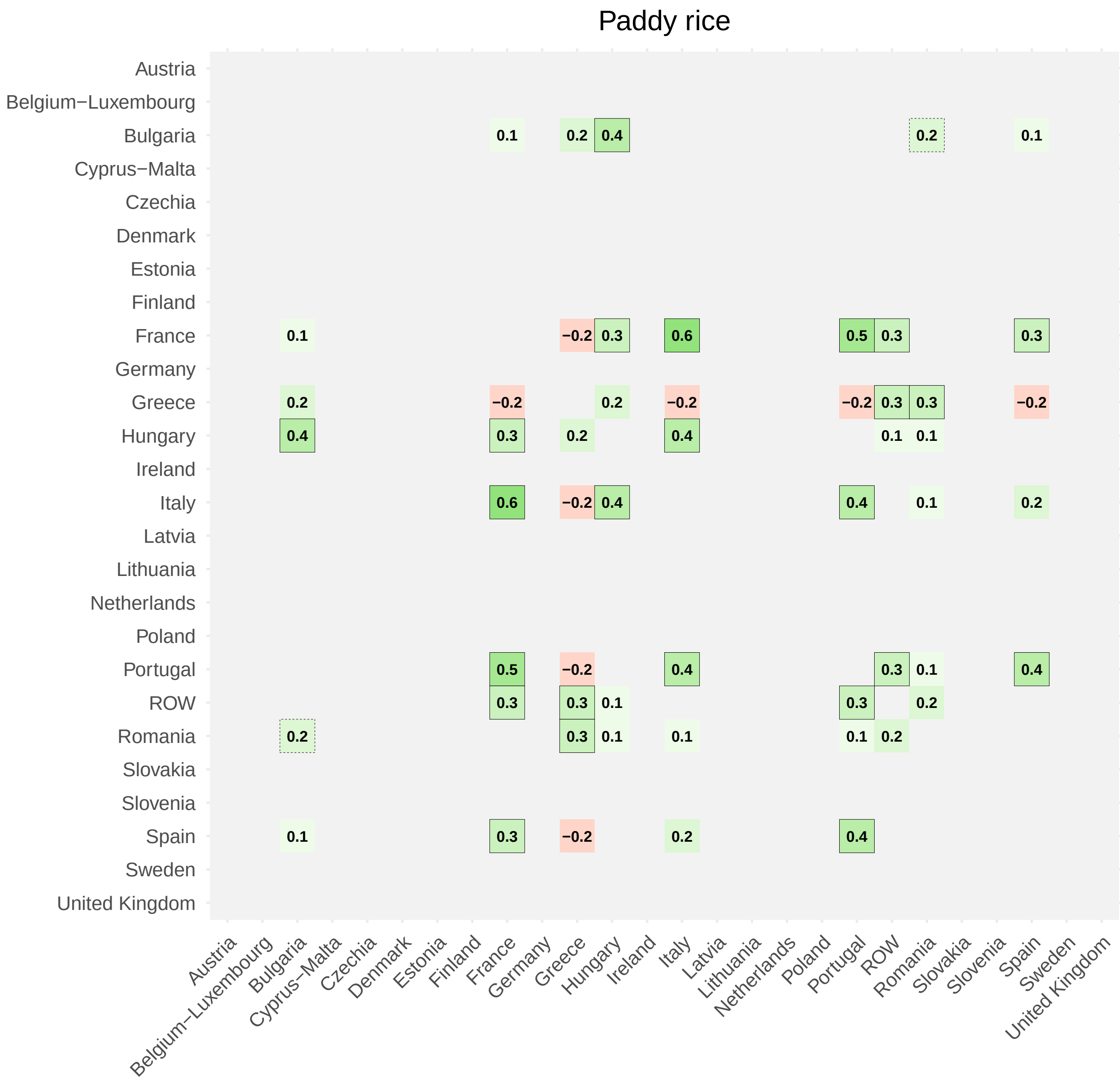

Raw sugar
Austria
Belgium−Luxembourg
Bulgaria
Cyprus−Malta
Czechia
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Latvia
Lithuania
Netherlands
Poland
Portugal
ROW
Romania
Slovakia
Slovenia
Spain
Sweden
United Kingdom


Grains
Austria
Belgium−Luxembourg
Bulgaria
Cyprus−Malta
Czechia
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Latvia
Lithuania
Netherlands
Poland
Portugal
ROW
Romania
Slovakia
Slovenia
Spain
Sweden
United Kingdom

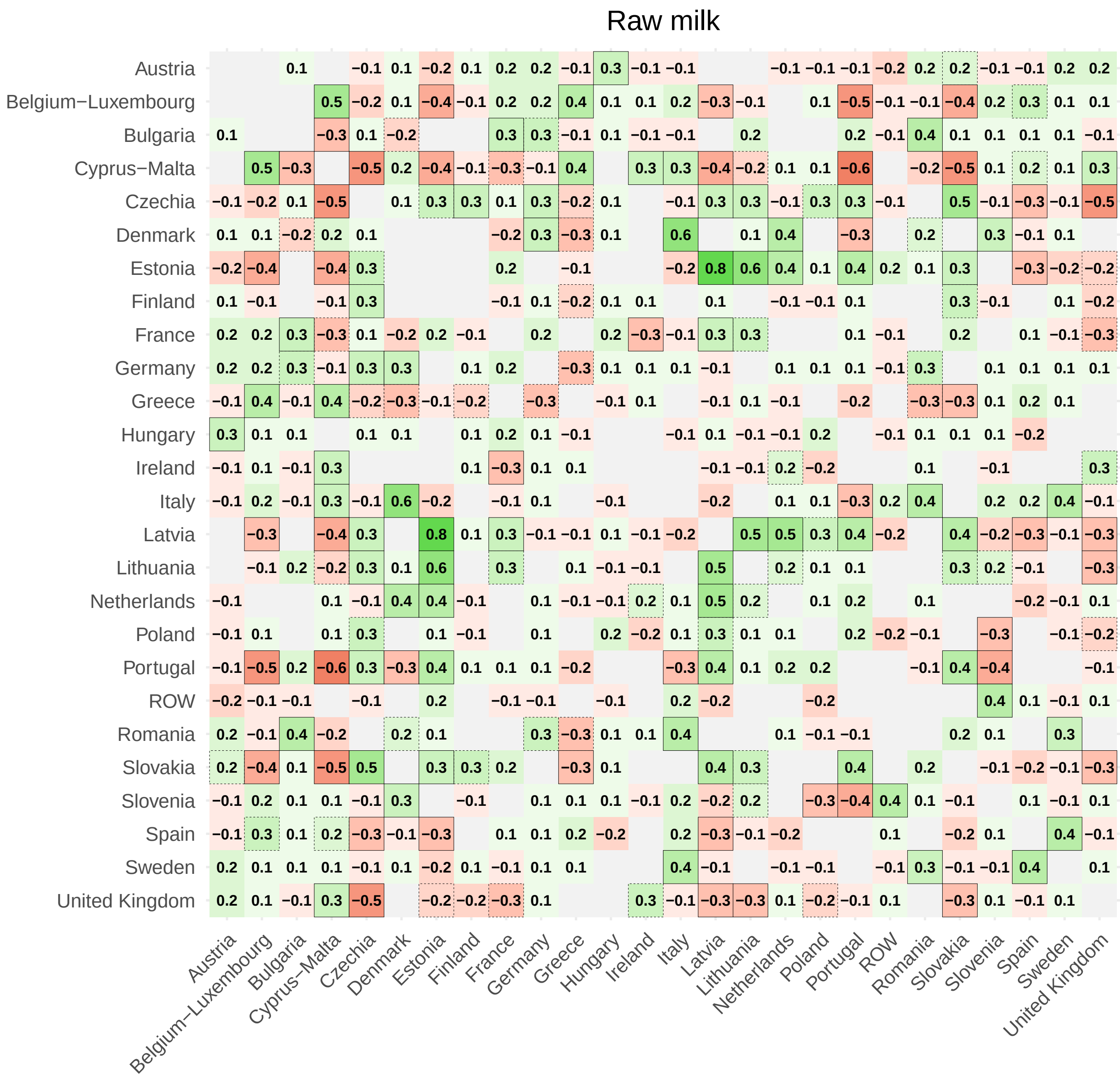

Pig and poultry
Austria
Belgium−Luxembourg
Bulgaria
Cyprus−Malta
Czechia
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Latvia
Lithuania
Netherlands
Poland
Portugal
ROW
Romania
Slovakia
Slovenia
Spain
Sweden
United Kingdom

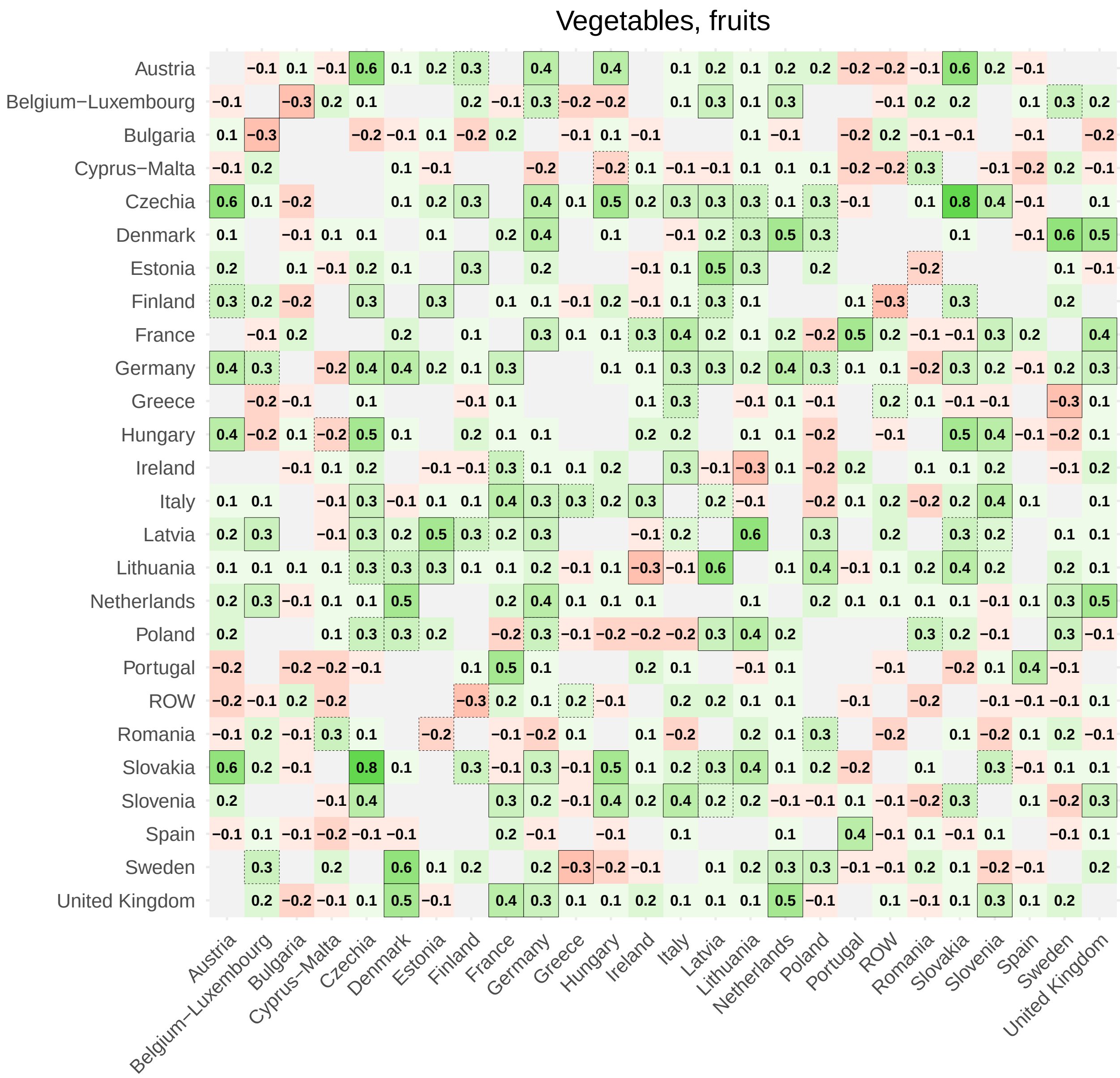

Other crops
Austria
Belgium−Luxembourg
Bulgaria
Cyprus−Malta
Czechia
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Latvia
Lithuania
Netherlands
Poland
Portugal
ROW
Romania
Slovakia
Slovenia
Spain
Sweden
United Kingdom

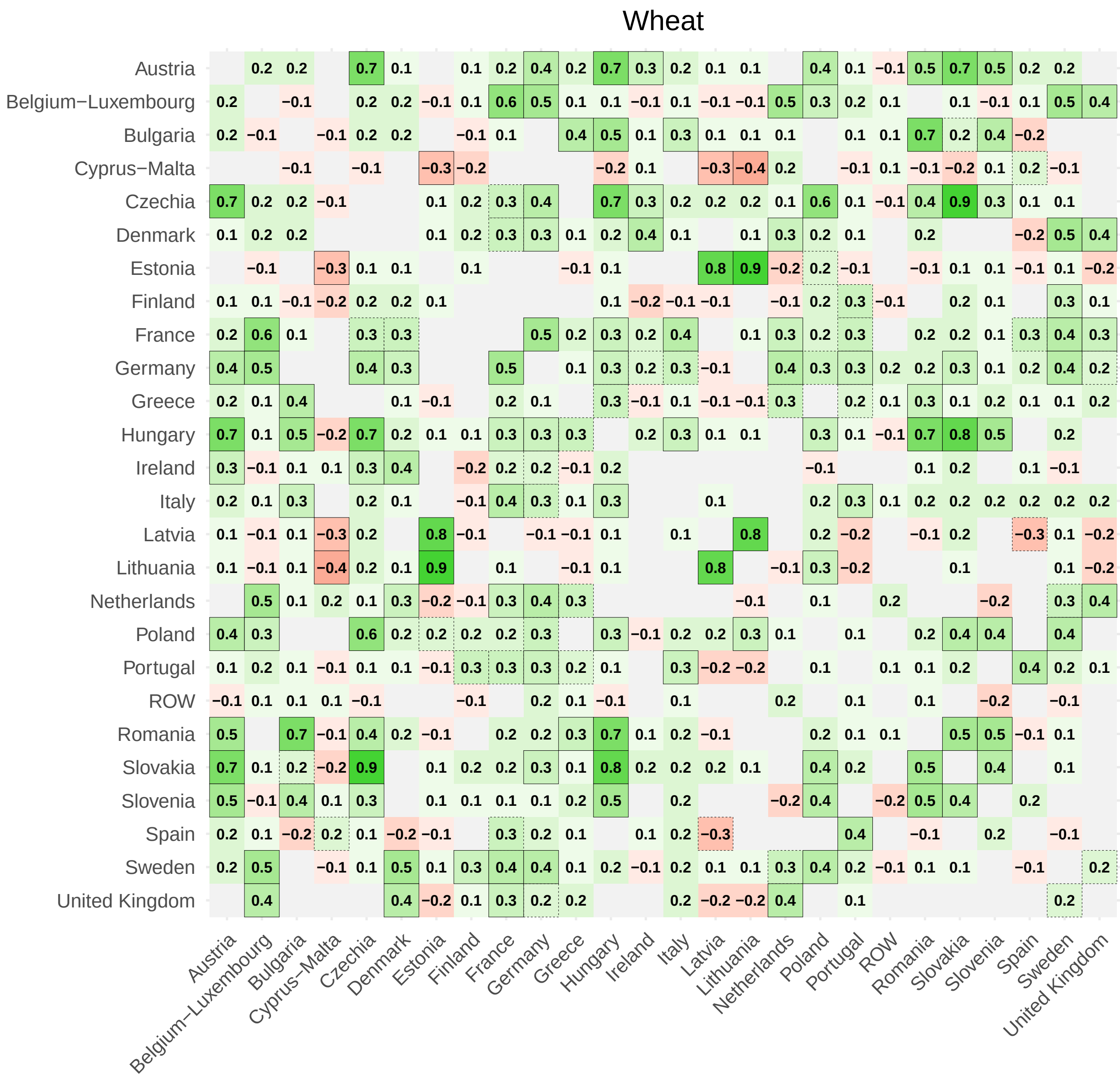

Oilseeds
Austria
Belgium−Luxembourg
Bulgaria
Cyprus−Malta
Czechia
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Latvia
Lithuania
Netherlands
Poland
Portugal
ROW
Romania
Slovakia
Slovenia
Spain
Sweden
United Kingdom



Paddy rice
Austria
Belgium−Luxembourg
Bulgaria
Cyprus−Malta
Czechia
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Latvia
Lithuania
Netherlands
Poland
Portugal
ROW
Romania
Slovakia
Slovenia
Spain
Sweden
United Kingdom


Raw milk
Austria
Belgium−Luxembourg
Bulgaria
Cyprus−Malta
Czechia
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Latvia
Lithuania
Netherlands
Poland
Portugal
ROW
Romania
Slovakia
Slovenia
Spain
Sweden
United Kingdom


Vegetables, fruits
Austria
Belgium−Luxembourg
Bulgaria
Cyprus−Malta
Czechia
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Latvia
Lithuania
Netherlands
Poland
Portugal
ROW
Romania
Slovakia
Slovenia
Spain
Sweden
United Kingdom


Wheat
Austria
Belgium−Luxembourg
Bulgaria
Cyprus−Malta
Czechia
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Latvia
Lithuania
Netherlands
Poland
Portugal
ROW
Romania
Slovakia
Slovenia
Spain
Sweden
United Kingdom