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The EU budget battle: Assessing the trade and welfare impacts of CAP budgetary reform

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ABSTRACT

There is a paucity of quantitative impact assessments of the sectorial and macroeconomic impacts of CAP budget reform for EU member states. To fill this gap, the current study employs a sophisticated agricultural variant of the GTAP model to evaluate the recently agreed CAP spending limits for the financial period 2014–2020 as well as a more radical 50% cut to the CAP budget proposed by the UK government. The study incorporates methodological innovation in terms of the modelling of CAP budgetary mechanisms. Furthermore, official EU auditing statistics are employed to (i) greatly improve the existing representation of agricultural support payments in the GTAP benchmark data and (ii) implement a detailed contemporary CAP baseline for member states to capture both the decoupled/coupled split of support payments and the distribution of support across both 'pillars'.

In general, CAP expenditure cuts have muted impacts on EU and world agricultural markets; whereas changes in net transfer payments have implications for real income and macro trade balances in EU member states. This observation is particularly pertinent when assessing conciliatory reductions in the UK rebate in exchange for deeper CAP budget cuts.

Introduction

Over fifty years since its inception, the common agricultural policy (CAP) remains one of the central tenets of the European Union (EU). Over this time period, the raison d'etre of the CAP has evolved radically from being a blunt policy instrument to promote self-sufficiency and farmer incomes, to a multifunctional model of 21st century agriculture reflecting broader societal concerns regarding the environment, rural livelihoods, food traceability, animal welfare, etc. As an illustration of this ongoing policy shift, the 2013 CAP reform seeks to further strengthen the relation between agricultural production and environmental responsibility by explicitly linking up to 30% of the direct payments envelope to greening practices (i.e., crop diversification, maintaining permanent pasture, etc.).

On its inception, the CAP budget mechanism was founded under the guiding paradigm of 'financial solidarity', where CAP budget transfers were targeted in respect of common policy objectives, regardless of the recipient member state.[1] Over time, however, this utopian vision of the CAP budget has had to withstand more pragmatic financial concerns. In 1984, the Fontainebleau European Council granted a rebate to the United Kingdom (UK),[2] which gave rise to a series of associated correction mechanisms to placate objections from other member states. The ensuing result is a complicated intra-community compensation mechanism which clearly challenges the principle of financial solidarity. Thus, whilst the CAP budget undeniably bestows non-pecuniary benefits which go beyond mere financial considerations (Le Cacheux, 2005), in a period of post-crisis austerity, fiscal responsibility and national political interests take precedence over EU ideology (Boulanger, 2011). Such sentiment was certainly in evidence when, in June 2013, a hard fought CAP budget agreement was reached for the next seven year spending plan – known as the multi-annual financial framework (MFF). Subsequently ratified by the Par-

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[1] "*The Community shall have as its task [...] by implementing common policies or activities [...] to promote throughout the Community [...] solidarity among Member States*" (Treaty Establishing the European Economic Community, March 25, 1957, art. [2]).

[2] At the time, despite being amongst the largest economies of the EU, the UK's per capita income was the second lowest of the ten member states, whilst agriculture's share of UK gross domestic product was relatively small (and remains so).

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Table 1
GTAP data aggregation.

I. Sectoral disaggregation (20 GTAP sectors)
Wheat; Other Grains; Oilseeds; Raw Sugar; Vegetables, Fruits and Nuts; Other Crops; Cattle and Sheep; Pigs and Poultry; Raw Milk; Wool; Red Meat; White Meat; Dairy; Sugar Processing; Other Food Processing; Beverages and Tobacco; Energy; Extraction; Manufacturing; Services
I. Regional disaggregation (27 GTAP regions)
United Kingdom (UK); Netherlands (NL); Sweden (SE); Denmark (DK); Germany (DE); Austria (AT); France (FR); Italy (IT); Spain (ES); Rest of the EU15 (Ro15); Poland (PL); Romania (RO); Rest of the EU15 (Ro12); Croatia (HR); European Free Trade Agreement (EFTA); United States of America (USA); Canada (CAN); Mercosur (MERC); Russian Federation (RUS); Eastern Partnership (EAP); China (CHN); India (IND); Japan (JAP); Australia & New Zealand (AUSNZ); Middle East & North Africa (MENA); Less Developed Countries (LDC); Rest of the World (ROW)

liament and the Council, this deal contemplates nominal expenditure cuts of 13% in pillar 1 (market measures and direct payments) and 18% pillar 2 (rural development measures) for the 2014–2020 period.

Against this background, it is perhaps surprising that there is a paucity of impact assessments examining the sectorial and macroeconomic impacts of CAP budget cuts. One exception is Nowicki et al. (2009), which employs a multi-region computable general equilibrium (CGE) framework to examine different CAP policy scenarios to 2020. Under the 'baseline', or *status quo* scenario the CAP budget is cut by 20% in real terms (constant in nominal terms), via a 30% cut in pillar 1 and a 105% increase in pillar 2. At the other extreme, a stylised 75% budgetary reduction in real terms (55% in nominal terms) is modelled via the elimination of pillar 1 and a 100% increase in pillar 2 compared with the baseline. Although offering interesting insights, this study does not provide a comprehensive representation of pillar 2 payments, nor is there any consideration given to EU member state contributions to finance CAP budgetary expenditures (known in EU parlance as the 'own resources' mechanism). In other (CGE) multi-region impact studies, a representation of the CAP budget is included as a vehicle to more fully quantify EU enlargement costs (Brockmeier et al., 2003; Philippidis and Karaca, 2009). These studies do include an own resources module, although the rebate mechanism is either absent (Brockmeier et al., 2003) or incomplete (Philippidis and Karaca, 2009). In addition, neither study makes any provision for pillar 2 payments.

In seeking to assess the sectorial and macroeconomic impacts of CAP budgetary reform, the present study also employs a multi-region CGE framework. Since the accompanying database exhibits coverage of economy-wide and gross bilateral trade activity for all individual EU member states, it is possible (and more desirable from a modelling perspective) to fully endogenise the behavioural and accounting conventions of the CAP budget within the model framework (i.e., member state receipts and contributions, UK rebate and subsequent 'corrective' mechanisms). As a result, for those countries under consideration, one can directly examine the sectorial impacts (i.e., prices, output) in agricultural and non-agricultural activities arising from CAP expenditure cuts and concomitant productivity changes (see later), as well as the 'income transfer' implications for the broader macro-economy arising from changes in net-contributions to the CAP budget.

In addition to the agreed CAP budget cut for the 2014–2020 MFF, this study also contemplates an 'upper limit' 50% cut in nominal expenditure which was proposed by the UK government during the negotiations (Agrafacts, 2012). In part, this proposal was a defensive posture in response to those EU member states calling for the elimination of the UK rebate, but was also made in direct reference to the 2008–2009 CAP budget review.[3] As a significant improvement on the current literature, official audit data from the European Commission is employed to fully capture pillar 2 expenditures within the CAP budget and model database. Moreover, this data source is also used to correct inaccuracies in the coverage of EU domestic support in the CGE model database as well as provide a principle source of information for the design of a highly detailed CAP baseline scenario capturing actual payment changes to agricultural sectors by EU member state under the CAP Health Check reforms (including the re-coupling of pillar 1 support payments). Finally, compared with the aforementioned literature, the modelling of the own resources component of the CAP budget is improved to include all UK rebate-related correction mechanisms.

The rest of this paper is structured as follows: Section two discusses the model framework, data and scenario design. Section three analyses the results, whilst section four concludes.

Methodology

Data and model framework

With its unparalleled level of commodity and country coverage, the well-known Global Trade Analysis Project (GTAP) database and associated CGE model framework (Hertel, 1997) is the *de facto* research methodology for examining the economic impacts of bilateral, regional and multilateral trade policy scenarios. In its latest incarnation, version 8.1 GTAP data (Aguiar et al., 2012) is benchmarked to 2007 and covers 57 commodities and 134 regions. As a first step, the GTAP toolkit constitutes an important point of departure. Notwithstanding, additional modelling and data work are necessary in state-of-the-art CGE applications to fully explore the agricultural policy specifics at hand. As a result, the current paper employs a GTAP variant, known as the Modular Agricultural General Equilibrium Tool (MAGNET).[4] A key strength of the MAGNET model is that it allows the user to choose *a la carte* those sub-modules of relevance to the study. Employing developments in the modelling literature, this version of MAGNET captures the specificities of agricultural factor and product markets to characterise the heterogeneity of land usage by agricultural activity; a regional endogenous land supply function; the sluggishness of capital and labour transfer between agricultural and non-agricultural sub-sectors with associated wage and rent differentials; the inclusion of substitution possibilities between feed inputs in the livestock sectors; and additional behavioural and accounting equations to explicitly characterise EU agricultural policy mechanisms (i.e., production quotas, single farm payment, pillar 2 payments). The MAGNET model also employs a recursive dynamic treatment of adaptive expectations investment behaviour which ensures that investment distribution across regions is consistent with exogenous shocks in capital (see Section 'Aggregation and closure') over successive time periods.[5]

[3] The statement of the 2008–2009 budget review clearly links CAP spending with UK rebate: "*The European Council…invites the Commission to undertake a full, wide ranging review covering all aspects of EU spending, including the CAP, and of resources, including the United Kingdom rebate, to report in 2008/9. On the basis of such a review, the European Council can take decisions on all the subjects covered by the review. The review will also be taken into account in the preparatory work on the following Financial Perspective*" (European Council, 2005).

[4] For a full description of the MAGNET model see Woltjer and Kuiper (2014).

[5] Given exogenous changes in capital stocks, regional rates of return adjust endogenously such that investment flows respect the (medium to long-run) assumption of a constant capital stock to output ratio in each region (see ch. 14, Woltjer and Kuiper, 2014).

In addition, the current paper incorporates a series of further refinements to the GTAP data and MAGNET model structure to improve the precision of the study, which are fully discussed in Appendices A and B. As a first step, a full inventory of the GTAP EU domestic support data employing the documentation from Jensen (2010) is conducted. Additional programs are written to explicitly identify payment totals corresponding to all classes of CAP support (i.e., 'decoupled'; 'coupled direct payments'; 'market measures'; 'additional direct transfers'; 'other EAGF payments'; 'agri-monetary transfers'; 'rural development Axis 1 and 2 payments'),[6] which are cross referenced with their payment source (i.e., national governments or EU); the relevant tax wedge in the GTAP data (i.e., *ad valorem* intermediate input-, output- or factor taxes) and the recipient GTAP agricultural sector. A comparison with the EU's Clearance Audit Trail System (CATS) data,[7] demonstrated the need for a more comprehensive picture of pillar 2 EU domestic support policies in the 2007 benchmark (see Appendix A). Moreover, a recalibration of the standard GTAP data is performed to link pillar 1 decoupled payments exclusively to the land factor, thereby breaking the link between the payment received and the farmer's production decisions (i.e., a 'coupling factor' of zero).

A thorough knowledge of EU domestic support payments in the GTAP data also serves as an essential starting point for designing and implementing a detailed CAP baseline. Employing time series data on pillar 1 and 2 from the CATS database allows one to contemplate meticulous contemporary CAP policy shocks, in particular the re-coupling of support payments under the auspices of the so-called article 68 provision (formerly article 69). To the best of our knowledge, this level of detail in the coupled/decoupled split has not been attempted in previous EU focused CGE applications. To further support this extension, additional variables are inserted into the CAP budget module to link each class of support payment with both the relevant tax variables and the CAP budget accounting equations. Finally, the MAGNET model is also extended to capture the own resources mechanism, complete with the UK's rebate and associated correction mechanisms (see Appendix B).

Aggregation and closure

For the purposes of this study, the GTAP data is aggregated to 20 tradables, of which 16 are agri-food related, and 27 countries or regions (Table 1). For the choice of EU regions, those members which benefit from budget rebates are separated, (i.e. UK, Germany, Netherlands, Austria, Sweden, and Denmark). As significant recipients of CAP funding, France, Spain and Italy are also disaggregated, whilst Poland and Romania represent large recipient members under the 2004 and 2007 enlargements, respectively. The remaining EU countries are aggregated into 'Other EU15' and 'Other EU12'. Lastly, as the 28th EU member state from July 1st, 2013, Croatia is treated separately. To examine possible third country impacts from CAP budget reform, non EU regions are grouped into either 'large players' on global agri-food markets or impoverished partners. All residual trade and output flows are captured within a Rest of the Word (ROW) region.

In terms of the model closure, all primary factor endowments (except land) and policy variables (*ad valorem* taxes and tariffs) are assumed exogenous. In neoclassical CGE models, technical change is traditionally treated as exogenous. This study takes the same approach, although output- and input-augmenting technical changes in relation to pillar 2 expenditures are treated endogenously.[8] To ensure macro closure, withdrawals (savings (S), imports (M) and CAP contributions (CC)) must equal injections (investment (I), exports (X) and CAP receipts (CR)).[9] Under conditions of fixed savings rates and steady state investment behaviour, with marginal CAP budget changes (i.e., CC – CR), the trade balance must adjust such that the regional balance of payments sums to zero. At the margin, this modification has important implications for the model results (see Section 'Results and discussion').

Scenario design

Table 2 describes the policy shocks within the baseline, which is implemented over two time periods (2007–2013–2020) to reconcile with the MFF and Croatia's accession to the EU. For the macro projections shocks (I.a. and II.a. in Table 2), labour projections are assumed to follow changes in regional population, whilst capital endowment shocks are equal to regional macro growth forecasts (i.e., fixed capital-output ratio). Data on macro growth and population projections are sourced from USDA (2013) whilst land productivity data is from IMAGE (Bruinsma, 2003). Trade policy shocks (I.b. and II.b. in Table 2) are focused on existing or planned commitments within the 2007–2020 time horizon, whilst further potential multilateral (i.e., Doha) and bilateral (i.e., United States, Mercosur, Japan, etc.) trade shocks are not contemplated due to the uncertainty of a firm timetable for agreement.

In terms of agricultural policy shocks (I.c and II.c in Table 2), the 2007–2013 period incorporates detailed sector and region specific pillar 1 and 2 'actual' expenditures (i.e., not ceiling limits) up to 2011 taken from the CATS database (see Appendix B). Pillar 2 payments are aggregated to five categories employed within the MAGNET model ('agri-environmental schemes'; 'least favoured areas'; 'physical capital'; 'human capital' and 'wider rural development'). Given the 'co-financed' nature of pillar 2 support between EU and individual member state budgets, policy shocks to national government pillar 2 spending are also implemented in the first period based on the CATS data. In the second period, owing, to a lack of alternative data, it is assumed that both the co-finance rates and the distribution of pillar 2 expenditures in member states remain the same as in the first period. Payment totals for Croatia in the second period are taken from European Commission (2009), whilst exogenous projections for the CAP budget over the 2014–2020 MFF are taken from European Commission (2011).

In addition to the baseline shocks, three CAP budget cut scenarios are explored in the second period. In each case, exogenous

[6] This typology of EU domestic support employed in the GTAP database cross-references Jensen (2010) with the EU budget codes (EAGF and EAFRD for pillar 1 and pillar 2 support respectively). In broad terms: '*decoupled*' includes those subsidies with no link between the payment and the production of a specific product (i.e. single payment scheme (SPS) and single area payment scheme (SAPS)); '*coupled*' maintains a link between those payments received and the specific product or type of farming to which they are targeted (i.e. animal premium, area aid, payment for specific commodities in LFAs or outermost regions, etc.); '*market measures*' include instruments which form part of the agricultural intervention mechanisms (i.e., vineyard restructuring, specific aid for peas, beans, wine, sugar, etc.); '*additional direct transfers*' is an account composite reflecting a modulation redistribution mechanism (which appeared in the old EAGF financial framework period but now no longer used); '*other EAGF payments*' includes support under health and consumer protection (i.e. veterinary measure, phytosanitary intervention, etc.); '*agri-monetary transfers*' includes residual transfers related to currency fluctuations; '*rural development Axis 1 and 2 payments*' includes those pillar 2 payments which aim to improve the competitiveness of the agricultural sector, the environment and the countryside.

[7] The Clearance Audit Trail System (CATS) database gathers details of all CAP payments made to the recipients of the EAGF (European Agricultural Guarantee Fund) and EAFRD (European Agricultural Fund for Rural Development), and previously (up until financial year 2006) to the recipients of the EAGGF (European Agricultural Guarantee and Guidance Fund). These data are provided by the member states to the Commission on an annual basis for the purposes of carrying out the clearance of accounts, monitoring developments and providing forecasts in the agricultural sector (European Commission, 2013). Recently CATS data have been used by the European Commission to perform the impact assessment accompanying the 2013 CAP reform proposals or CAP towards 2020 (European Commission, 2011). For more discussion on the CATS database, see Appendix A.

[8] See Appendix 'Pillar 2 payments and productivity effects' for a discussion on the treatment of pillar 2 productivity effects.

[9] In the non-EU regions, both CR and CC are zero.

Table 2
Assumptions shaping the baseline scenario.

I. Baseline shocks (2007–2013 period)
I.a. Projections
• Skilled and unskilled labour, capital, natural resources, population, and macro growth
I.b. Trade policy shocks
• Non reciprocal EU tariff eliminations with the Everything But Arms countries
I.c. Agricultural policy (including 2008 Health Check reforms)
• Phasing in of decoupled payments for 2004 and 2007 accession members
• Targeted removal of specific pillar 1 coupled support payments: Arable crops, olives and hops to be fully decoupled from 2010; Seeds, beef and veal payments (except the suckler cow premium) decoupled by 2012, Protein crops, rice and nuts will be decoupled by 1 January 2012, Abolish the energy crop premium in 2010
• Re-coupling of support under the article 68 provision: Member states may use up to 10 per cent of their financial ceiling to grant measures to address disadvantages for farmers in certain regions specialising in dairy, beef, goat and sheep meat, and rice farming
• Pillar 2 payments to the EU27 under the financial framework
• Cumulative shocks for milk quotas rise of 1 per cent annually from 2009 to 2013
• Projected reduction in CAP expenditure share of the EU budget
• Change in Swedish and Dutch lump sum rebates corresponding to CAP expenditure share of EU budget
II. Baseline shocks (2013–2020 period)
II.a. Projections
• Skilled and unskilled labour, capital, natural resources, population, and real GDP
II.b. Trade policy shocks
• EU Enlargement elimination of border protection between incumbent EU27 and Croatia
• Erection of an EU common external tariff (CET) on third country trade for Croatia and reciprocal third country CETs extended to Croatia as an EU member
• Non reciprocal EU tariff eliminations with the MENA, Eastern Partnership and Sub-Saharan Africa regions
• Non reciprocal EU tariff eliminations extended to Croatia
• Removal of all export refunds
II.c. Agricultural policy
• Phasing in of decoupled payments for 2007 accession members and Croatia
• Pillar 2 payments extended to Croatia
• Abolition of raw milk (2015) and raw sugar (2017) quotas
• Croatia incorporated within the CAP budget and UK rebate mechanism
• Projected reduction in CAP expenditure share of the EU budget
• Change in Swedish, Dutch and Danish lump sum rebates corresponding to CAP expenditure share in EU budget. UK rebate is maintained (European Council, 2013)

reductions are applied to pillar 1 and 2 expenditures and the EU budget share of the CAP budget assuming that the non-agricultural spending concepts remain unchanged.[10] In scenario 1, consistent with the political agreement reached on June 27, 2013, pillar 1 and pillar 2 nominal expenditures are cut 13% and 18%, respectively (European Council, 2013). This corresponds to a 15.2% cut in nominal CAP budgetary funding. Scenarios 2 and 3 explore politically expedient upper limits to the CAP budget cut. During the negotiations, the UK pushed for a cumulative €200 billion cut over the 2014–2020 financial period (Agrafacts, 2012), which corresponds to a 50% nominal expenditure cut to the CAP budget by 2020. Thus, scenario 2 imposes a uniform 50% cut to both pillars, whilst in scenario 3 it is assumed that under the same 50% budget cut the UK makes a conciliatory reduction to its rebate to the extent that its net CAP position remains the same as in the baseline.

Results and discussion

CAP budget and welfare impacts

In this section, unless otherwise stated, estimates are presented in comparison with the baseline (*status quo*) scenario. The complexity of the CGE model framework renders a full discussion of all the model results as unwieldy. Thus, the focus is on the CAP budgetary and welfare effects, as well as the output, price and trade balance impacts for specific regional and sectoral aggregates.[11] To understand the driving mechanism behind the results, a useful starting point is the representation of the revenues and costs corresponding to the CAP budget at the end of the baseline period 2007–2013 (top part of Table 3). The last column of the first row shows total CAP receipts of €52,340 million accruing to the EU member states. This total is split between pillars 1 and 2 amounting to €41,114 million and €11,222 million, respectively.[12] Of the former, decoupled payments total €38,435 million and remaining coupled payments sum to €2684 million.[13] Contributions to the CAP budget are financed by tariff revenues and a uniform EU-wide percentage of each member's gross domestic product (GDP). The rebate row in Table 3 accounts for the net impacts on EU members from both the UK rebate and additional corrective payments.

The 'net position' row shows that the 'old' EU15 (except Spain, RoEU15 and Austria) are net contributors to the CAP budget, whilst the newer member states (as expected) are net beneficiaries. This observation underlies the redistributive nature of the CAP. A closer look reveals that France is the largest recipient of CAP funding, but makes significant payments to the CAP budget and the UK rebate whilst receiving no special dispensation. On the other hand, the Austrian rebate (in the form of reduced GDP contributions) renders this country as a small net beneficiary from the CAP. As a percentage of GDP the largest net contributors are Germany and the Netherlands (0.18% and 0.15% respectively) despite the fact that both receive partial rebates. Moreover, even with a sizeable rebate, the UK is still a net contributor to the CAP budget (−€1733 million or 0.08% GDP). The newer member states typically receive net support which ranges from 0.6% to 0.8% of GDP.

On the basis of these estimates, a CAP budget cut would benefit (detriment) net contributors (net beneficiaries) in the form of a taxpayer saving (loss). In the model, income changes feedback to each economy as an increase (decrease) in expenditure and savings. This effect is demonstrated in the lower part of Table 3. As an initial observation, the results are consistent for scenarios 1 and 2 in terms of the comparative magnitudes across regions and

[10] Given the focus of this study, no attempt is made to model the complexities of remaining EU budgetary policies (e.g., structural funds).

[11] A full set of results for all regions and sectors is available from the authors upon request.

[12] The pillar 2 figure reported in Table 3 excludes nationally co-financed support.

[13] In the GTAP database, coupled payments are assigned to subsidies on output, intermediate inputs (both domestic and imported), land and capital (see Appendix A).

Table 3
The CAP budget (€millions, 2007 prices).

	UK	NL	SE	DK	DE	AT	FR	IT	ES	Rof15	PL	RO	Rof12	HR	EU28
A. CAP budget estimates in 2013															
1. CAP receipts	3671	1228	930	964	6410	1242	8390	5084	6096	6708	4359	1816	5443	0	52340
Pillar I: Decoupled	3013	1115	654	888	5177	622	6888	3752	4352	4633	2744	1018	3579	0	38435
Pillar I: Coupled	62	43	10	21	88	80	728	250	761	510	27	43	61	0	2684
Pillar 2: LFA	54	1	41	1	157	126	292	105	72	419	243	109	289	0	1909
Pillar 2: agri-env.	348	22	149	27	364	272	218	341	392	510	241	112	524	0	3521
Pillar 2: physical K	73	12	26	5	288	56	120	413	303	340	278	135	475	0	2526
Pillar 2: human K	20	1	12	8	4	15	71	103	90	157	403	53	105	0	1044
Pillar 2: wider dev.	96	34	37	14	332	70	73	123	127	138	423	346	409	0	2222
2. CAP contribution	8458	2537	1487	953	10822	1152	7708	5933	4055	4925	1635	605	2070	0	52340
3. Rebates	3054	431	89	−96	−325	−37	−932	−697	−471	−532	−190	−70	−224	0	0
4. Net position	−1733	−878	−468	−85	−4737	53	−250	−1546	1571	1251	2534	1141	3149	0	0
% of GDP	−0.08	−0.15	−0.12	−0.04	−0.18	0.02	−0.01	−0.10	0.16	0.11	0.63	0.76	0.66	0.00	
B. Scenario 1: Budget agreement (MFF) vs. baseline in 2020															
1. CAP receipts	−507	−163	−134	−128	−891	−188	−1129	−716	−842	−950	−646	−253	−574	−65	−7187
2. CAP contribution	−1199	−336	−204	−132	−1439	−157	−1050	−760	−539	−674	−260	−96	−312	−28	−7187
3. Rebates	−445	−36	−6	6	40	5	128	90	64	75	31	11	35	3	0
4. Net position	246	137	64	10	589	−26	49	135	−239	−202	−356	−146	−228	−33	0
C. Scenario 2: UK proposal of 50% cut in CAP budget vs. baseline in 2020															
1. CAP receipts	−1835	−614	−465	−482	−3205	−621	−4195	−2544	−3048	−3354	−2179	−828	−1862	−217	−25451
2. CAP contribution	−4248	−1194	−722	−468	−5103	−556	−3709	−2690	−1908	−2393	−915	−337	−1107	−100	−25451
3. Rebates	−1556	−116	−20	23	137	16	446	314	221	260	106	39	121	10	0
4. Net position	857	464	238	9	2036	−49	−40	460	−919	−702	−1159	−452	−635	−107	1
D. Scenario 3: UK proposal 50% cut in CAP budget plus UK rebate reduction vs. baseline in 2020															
1. CAP receipts	−1835	−614	−465	−482	−3205	−621	−4195	−2544	−3048	−3354	−2179	−828	−1862	−217	−25451
2. CAP contribution	−4250	−1194	−722	−468	−5103	−556	−3709	−2690	−1908	−2392	−915	−337	−1107	−100	−25451
3. Rebates	−2415	−104	−12	49	188	22	668	470	331	389	159	58	181	16	0
4. Net position	0	476	245	35	2086	−43	182	616	−809	−572	−1106	−433	−575	−101	0

Notes: 4 = 1–2 + 3. 'Rebate' includes UK rebate and lump sum corrective payments. CAP contribution includes both tariff and GDP payments.
The budget reduction in the 2007 and 2013 accession member states is below 50% compared with 2013, since these are still receiving additional payments in the 2013–2020 period.

the signs of the estimates. Notice that the agreed CAP budget cut (scenario 1) implies relatively small adjustment costs, where the biggest winner (loser) is Germany (Poland) with a gain (loss) of €589 million (−€356 million). These corresponding totals rise to €2036 million (−€1159 million) under the UK's proposal (scenario 2). In scenario 3, the UK is estimated to relinquish €2415 million in rebate to remain financially equivalent to the baseline CAP budgetary position, of which the largest beneficiary is France (€668 million) followed by Italy (€470 million).

Table 4 presents a decomposition of the real income or equivalent variation (EV) changes for a selection of regions. Measured in per capita income terms, the impacts are muted owing to the localised nature of the shocks (i.e., restricted to EU agriculture). In the EU, the largest per capita real income gains accrue to net contributors, such as the Netherlands and Germany. This is consistent with the CAP budget cost as a percentage of GDP statistic reported in Table 3. Under a similar line of reasoning, the biggest per capita income losers are the new member states, especially Romania (between −0.2% (scenario 1) and −0.6% (scenarios 2 and 3)). The EV results show larger losses accruing to the 'new' EU13 states vis-à-vis the EV gains of the 'old' EU15 states. This result is driven by the endowment and technology effects (see Section 'Impacts on factor and product markets').

Decomposing EV into money metric measures, the dominating driver is the *CAP budget effect*, resulting in EV gains for the UK, the Netherlands, Germany and France and concomitant losses in Spain, Poland and Romania.[14] Elsewhere, EU members generally realise *allocative efficiency* gains due to the contraction in agricultural activities; increased imports of tariffed manufactured goods; and output rises in domestic services sectors (see Section 'Impacts on factor and product markets').[15] In Spain, Poland and Romania, although subsidised agricultural activity contracts (i.e., allocative efficiency gain), manufacturing imports and domestic services output also fall relative to the baseline resulting in net allocative efficiency falls. As the unit price ratio of exchange between exports and imports, the *terms of trade* impact in the EU regions is the net result of (i) increasing agri-food prices from partial elimination of agricultural support and (ii) changes in the real exchange rate (i.e., factor prices).[16] The *endowment effect* measures incremental real income impacts through changes in factor usage. This value is reported as negative in the EU regions due to the idling of agricultural land from the CAP budget cuts and is an explanatory factor for the fall in EU28 EV.

The *technology measure* captures the money metric equivalent from improvements in output or input augmenting technical change. Under budget cuts, reductions in pillar 2 investments in human and physical capital in agriculture and wider rural measures generate productivity losses in agricultural and (to a lesser extent) non-agricultural sectors. This negative effect is particularly pronounced in Poland. In contrast, the UK and Austria witness small positive technological EV gains because approximately 60%

[14] Although the results are not shown for all the EU regions, as a rule, net contributors to (beneficiaries of) the CAP budget realise EV gains (losses).

[15] Allocative efficiency gains arise from changing resource or product usage in the presence of market distortions (taxes, tariffs and subsidies). For example, a taxed activity leads to below pareto optimal purchases/employment of a product or factor, such that policies that encourage increased usage of that product or factor result in an allocative efficiency gain.

[16] In the UK and the Netherlands, real macro growth rises slightly leading to small *increases* in wages and capital rents compared to the baseline. This result is discussed in Section 'Impacts on factor and product markets'.

Table 4
EV impacts in selected regions vs. baseline in 2020 (€millions, 2007 prices).

	UK	NL	DE	FR	ES	PL	RO	EU15	EU13	EFTA	USA	MERC	AUSNZ	CHN	IND	JAP	LDC
Scenario 1: Budget agreement (MFF)																	
EV	299	182	593	14	−346	−723	−321	482	−1525	−11	103	141	26	−30	−4	−8	54
Per cap U (%)	0.01	0.03	0.02	0.00	−0.03	−0.15	−0.20	0.00	−0.12	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Decomposition:																	
ALLOC	19	14	91	32	−11	−39	−34	241	−63	−9	1	23	2	−11	36	−3	6
TOT	24	41	53	20	−39	−77	−95	27	−218	−5	72	89	19	−19	−16	−6	27
ENDW	3	−7	−89	−61	−12	−65	−13	−323	−149	3	16	17	1	−25	−22	1	8
TECH	4	−4	−42	−28	−38	−194	−42	−213	−352	0	8	7	2	23	−3	0	8
POP	6	3	−4	1	−8	4	3	−4	11	0	6	5	1	2	1	0	4
CAP	243	135	585	49	−238	−353	−141	754	−753	0	0	0	0	0	0	0	0
Scenario 2: UK proposal (50% cut in CAP budget)																	
EV	1027	628	2023	−235	−1296	−2256	−976	1299	−4607	−46	393	531	98	−114	−224	−40	210
Per cap U (%)	0.05	0.10	0.08	−0.01	−0.13	−0.46	−0.62	0.01	−0.37	−0.01	0.00	0.02	0.01	0.00	−0.01	0.00	0.00
Decomposition:																	
ALLOC	66	50	306	80	−45	−108	−101	785	−157	−38	4	88	8	−46	−19	−13	23
TOT	75	148	172	39	−147	−242	−289	34	−655	−22	264	333	71	−96	−102	−30	102
ENDW	11	−27	−334	−237	−52	−229	−43	−1218	−519	12	58	61	5	−94	−114	2	32
TECH	11	−12	−128	−76	−105	−540	−116	−610	−984	1	37	27	8	108	1	1	34
POP	21	9	−14	−1	−31	11	10	−17	34	0	29	22	5	14	11	−1	18
CAP	843	459	2021	−40	−916	−1149	−437	2325	−2326	0	0	0	0	0	0	0	0
Scenario 3: UK proposal (50% cut in CAP budget) plus UK rebate reduction																	
EV	−67	643	2084	43	−1158	−2187	−943	1108	−4425	−47	398	533	99	−109	−222	−37	211
Per cap U (%)	0.00	0.11	0.08	0.00	−0.11	−0.45	−0.60	0.01	−0.35	−0.01	0.00	0.02	0.01	0.00	−0.01	0.00	0.00
Decomposition:																	
ALLOC	−13	51	311	100	−36	−103	−98	775	−142	−38	4	88	8	−44	−17	−13	23
TOT	−79	150	178	74	−131	−231	−278	−10	−623	−23	269	334	72	−93	−102	−28	104
ENDW	6	−26	−333	−236	−51	−228	−42	−1220	−516	12	59	61	5	−94	−115	2	32
TECH	18	−12	−129	−78	−106	−541	−116	−607	−986	1	38	27	8	108	1	1	34
POP	2	9	−15	3	−28	11	10	−27	32	0	29	22	5	14	11	−1	19
CAP	0	471	2071	180	−806	−1097	−419	2196	−2191	0	0	0	0	0	0	0	0

Notes: 'ALLOC' is allocative efficiency; 'TOT' is terms of trade; 'ENDW' is endowment effect; 'POP' is population effect; 'CAP' is CAP budget effect.

of their pillar 2 expenditure (including co-financed support) is assigned to (productivity reducing) agri-environmental measures.

Comparing between scenarios 2 and 3, the UK witnesses an EV loss (Table 4), due to its reduced rebate, whilst the UK's real exchange rate depreciation compared with the baseline (not shown) leads to a terms of trade deterioration. Moreover, the reduction in UK real income in scenario 3 lowers demand for both manufacturing imports and services output, resulting in negative allocative effects.

In the non-EU regions, per capita real income impacts are negligible due to the largely non-distortionary nature of EU agricultural policy (Table 4). On the other hand, the results clearly show that agricultural net exporters (e.g., USA, MERC, AUSNZ) gain, with concurrent losses in net importing regions (EFTA, China, India, Japan). This reflects the slight increase in agricultural export prices which has beneficial (detrimental) terms of trade impacts for agricultural net exporters (importers). Interestingly, there is (limited) scope for less developed country (LDC) welfare gains from the budget cuts, although this result masks the heterogeneity of relative agricultural trade competitiveness within this regional aggregate.

Trade impacts

Table 5 presents changes in the trade balances for a selection of EU and non-EU regions. Given the nature of the experiment design, trade balances changes are linked with the macro closure discussed in Section 'Aggregation and closure'. For a net paying member state to the CAP budget, the proposed cuts reduce budget contributions proportionally more than budget receipts. At the margin, this CAP budget saving generates an EV gain leading to rising imports. In policy terms, increases in real incomes are accompanied by rises in the marginal propensity to import, resulting in trade balance deteriorations. The same logic applies in the opposite direction for net recipients of CAP funds with falling EV. For example, under the current political agreement for CAP budget reform (scenario 1) the EU15 trade balance deteriorates by −€681 million, whilst the EU13 trade balance improves €1528 million. Since the EV loss for the EU13 exceeds the EU15 EV gain, the EU28 trade balance consequently improves €847 million. Under the general closed system of global accounting equations, an improved EU28 net trade balance is accompanied by a corresponding (minor) deterioration in non-EU region trade balances.

In scenario 1, the EU28 agricultural and food trade balances deteriorate −€410 million and −€260 million, respectively (Table 5). In scenarios 2 and 3, these figures deteriorate by approximately −€1500 million and −€950 million, respectively. As expected, non-EU28 agricultural net exporting regions (e.g., USA, MERC & AUSNZ) witness small agri-food trade balance improvements in all scenarios.[17] Across the EU's non agri-food sectors, the trend follows that of the macro trade balance. Thus, in the EU15, with a rising propensity to import (and higher income elasticities for non-food products), the trade balance deterioration in manufacturing and services is a rising function of the size of the CAP budget cut. In the EU13, the reverse occurs.

Impacts on factor and product markets

In Tables 6 and 7 are shown output and price impacts in selected EU regions under all three policy scenarios.[18] As expected, agricultural (and food) market price rises are driven in large part by

[17] Although not shown, agricultural world price rises are no greater than 0.6% even under conditions of a 50% CAP budget cut. This muted price effect also, in part, reflects the relatively high armington elasticities employed within the GTAP database.

[18] Corresponding simulation estimates in the non-EU regions are not shown since the results are negligible.

Table 5
Net trade balance effects vs. baseline in 2020 (€millions, 2007 prices).

	UK	NL	DE	FR	ES	PL	RO	EU15	EU13	EFTA	USA	MERC	AUSNZ	CHN	IND	JAP	LDC
Scenario 1: Budget agreement (MFF)																	
Agric	−3	5	−66	−35	1	−103	−10	−201	−210	−3	87	74	8	−3	12	−2	71
Food	34	6	−92	−20	−24	−107	28	−191	−69	12	45	37	28	10	−27	6	17
NatEnergy	−4	0	−6	2	3	15	10	0	36	−2	0	−17	−4	12	6	6	−9
Manu	−238	−104	−424	47	241	716	405	−278	1501	−23	−293	−211	−39	−32	−13	−71	−125
Servs	−125	−53	−75	10	107	115	60	−12	269	−9	−87	−48	−18	15	8	−10	−33
MACRO	−335	−146	−663	3	327	637	493	−681	1528	−24	−248	−165	−26	2	−13	−72	−79
Scenario 2: UK proposal (50% cut in CAP budget)																	
Agric	−27	13	−292	−168	6	−312	−30	−886	−650	−11	329	283	30	−13	11	−9	271
Food	114	21	−370	−78	−93	−306	86	−765	−181	39	168	133	107	38	−63	20	63
NatEnergy	−12	2	−19	12	11	51	31	18	114	−7	1	−64	−16	47	27	21	−34
Manu	−810	−352	−1343	438	927	2235	1222	−368	4556	−76	−1057	−780	−145	−51	115	−244	−472
Servs	−430	−181	−240	96	402	358	182	94	811	−32	−319	−176	−66	57	79	−35	−123
MACRO	−1166	−496	−2264	301	1253	2026	1490	−1906	4649	−86	−877	−605	−91	77	169	−247	−296
Scenario 3: UK proposal (50% cut in CAP budget) plus UK rebate reduction																	
Agric	−25	13	−293	−168	5	−312	−31	−886	−652	−11	330	283	30	−13	11	−9	271
Food	160	21	−371	−92	−98	−310	83	−758	−191	39	169	134	107	38	−63	20	63
NatEnergy	1	2	−20	9	10	50	29	21	110	−7	2	−65	−15	46	27	20	−33
Manu	−119	−357	−1384	248	851	2175	1176	−231	4392	−74	−1051	−783	−145	−49	117	−243	−473
Servs	−102	−188	−255	41	358	347	175	189	773	−34	−335	−178	−67	54	75	−39	−126
MACRO	−86	−508	−2322	38	1126	1949	1433	−1666	4432	−86	−886	−609	−91	76	167	−251	−297

Table 6
Output effects vs. baseline in 2020 (% changes).

	Scenario 1: Budget agreement (MFF)					Scenario 2: UK proposal (50% cut in CAP budget)					Scenario 3: UK proposal (50% cut in CAP budget) & UK rebate reduction				
	UK	DE	FR	PL	EU28	UK	DE	FR	PL	EU28	UK	DE	FR	PL	EU28
Land	−0.07	−0.82	−0.54	−0.45	−0.51	−0.32	−3.21	−2.24	−1.73	−2.00	−0.32	−3.21	−2.25	−1.73	−2.00
Wheat	0.06	−0.24	−0.18	−1.42	−0.29	−0.16	−1.17	−0.76	−4.49	−1.08	−0.13	−1.17	−0.76	−4.49	−1.08
Ograins	0.22	−0.18	−0.07	−0.87	−0.24	0.74	−0.89	−0.34	−2.77	−0.92	0.75	−0.89	−0.35	−2.77	−0.92
Oilseeds	0.00	−0.23	−0.18	−1.41	−0.29	−0.35	−1.22	−0.83	−4.48	−1.15	−0.33	−1.22	−0.83	−4.48	−1.15
Rawsugar	0.08	−0.12	−0.07	−0.10	−0.04	0.01	−0.51	−0.29	−0.39	−0.21	0.08	−0.51	−0.30	−0.39	−0.21
Vegfrunuts	0.06	−0.09	−0.15	−1.43	−0.17	0.00	−0.65	−0.68	−4.30	−0.64	0.01	−0.65	−0.68	−4.30	−0.64
Catshp	0.12	−0.01	−0.35	−0.98	−0.26	0.36	−0.07	−1.47	−2.34	−1.01	0.36	−0.07	−1.47	−2.35	−1.01
Pigspoultry	0.14	−0.21	−0.11	−1.04	−0.25	0.36	−0.90	−0.48	−3.15	−0.89	0.36	−0.89	−0.48	−3.15	−0.89
Rawmilk	0.11	−0.26	−0.03	−0.34	−0.14	0.37	−1.08	−0.12	−1.05	−0.51	0.37	−1.08	−0.12	−1.05	−0.51
AGRIC	0.12	−0.21	−0.15	−1.06	−0.22	0.31	−0.95	−0.65	−3.21	−0.83	0.31	−0.95	−0.65	−3.21	−0.83
Red meat	0.00	−0.11	−0.39	−0.53	−0.32	−0.07	−0.44	−1.55	−1.33	−1.18	−0.07	−0.43	−1.55	−1.34	−1.18
White meat	0.18	−0.28	−0.12	−0.98	−0.22	0.47	−1.13	−0.52	−2.95	−0.76	0.49	−1.13	−0.52	−2.95	−0.75
Dairy	0.12	−0.31	−0.03	−0.11	−0.11	0.42	−1.25	−0.11	−0.33	−0.42	0.42	−1.25	−0.11	−0.33	−0.42
Sugar	0.09	−0.16	−0.08	−0.08	−0.04	0.03	−0.70	−0.34	−0.33	−0.22	0.11	−0.70	−0.35	−0.33	−0.21
Vegoilsfats	0.06	−0.32	−0.45	0.36	−0.07	0.31	−1.15	−1.87	1.19	−0.17	0.38	−1.14	−1.88	1.17	−0.16
FOOD	0.03	−0.10	−0.05	−0.36	−0.08	0.10	−0.41	−0.20	−1.09	−0.30	0.09	−0.41	−0.21	−1.09	−0.30
NATENE	0.00	0.00	0.00	−0.01	0.00	0.00	0.00	0.00	−0.05	−0.01	0.00	0.00	0.00	−0.05	−0.01
MANU	−0.02	−0.02	0.00	0.17	0.01	−0.06	−0.05	0.03	0.54	0.04	−0.01	−0.05	0.01	0.53	0.04
SERV	0.00	0.01	0.00	−0.07	0.00	0.01	0.03	0.01	−0.22	0.00	0.00	0.03	0.01	−0.21	0.00

marginal cost increases in land rents paid by the farmer (row 2, Table 7). The magnitude of these cost-push increases is positively related to the magnitude of the CAP support cuts. Given this loss of competitiveness, agriculture and food production falls in the EU (Table 6), although the relative impact is less than 1% for the EU28, even under a 50% budget cut. Firstly, this is because pillar 1 agricultural support is predominantly production neutral. Indeed, even in those regions (e.g., France, Spain) which recouple support under the auspices of article 68, decoupled payments still constitute the majority of pillar 1 (90% in France and 85% in Spain). Moreover, given the medium run modelling assumption regarding the restricted movement of capital and labour to, and from agriculture, as well as the restrictions on land use changes, agricultural supply responsiveness is expected to be inelastic.[19] The larger price rises and production falls in Polish agriculture reflect productivity losses from cuts to its (considerable) pillar 2 investments. At the other extreme, UK agricultural activity increases slightly since the cut in its relatively large agri-environmental payments sets UK agriculture on a path toward a more intensive production system.

In the EU28 land market, falls in aggregate demand result in (marginal) land abandonment of between −0.5% (scenario 1) to −2% (scenarios 2 and 3) (Table 6). Due to the inelastic nature of the land supply curves, EU28 landowner rents (row 1, Table 7) fall more sharply, averaging −4% and −14% under scenarios 1 and 2, respectively. In policy terms, this largely reflects the lost capitalisation of land rents from reductions in the single farm payment.

In the services sector, there is a greater intensity of 'skilled labour' so service sector output is less affected by sectorally trapped agricultural unskilled labour. Moreover, the import dependency ratio for EU services is considerably below that of manufacturing (i.e., less import competition). Thus, in those EU regions where real income improves from CAP budget cuts (e.g., UK,

[19] Compared with the standard GTAP model, in this study agricultural labour (mainly unskilled) and capital are willing to accept larger wage or rent falls before moving to non agricultural activities.

Table 7
Market price effect vs. baseline in 2020 (% changes).

	Scenario 1: Budget agreement (MFF)					Scenario 2: UK proposal (50% cut in CAP budget)					Scenario 3: UK proposal (50% cut in CAP budget) &UK rebate reduction				
	UK	DE	FR	PL	EU28	UK	DE	FR	PL	EU28	UK	DE	FR	PL	EU28
Land (owner)	−5.80	−3.76	−4.97	−3.15	−4.06	−21.62	−13.27	−17.90	−11.27	−14.49	−21.60	−13.27	−17.90	−11.27	−14.49
Land (farmer)	2.35	6.91	4.98	2.81	4.34	7.99	28.56	21.29	10.85	17.38	8.04	28.57	21.28	10.85	17.39
Wheat	0.17	0.33	0.24	1.01	0.29	0.78	1.36	0.93	3.46	1.11	0.77	1.37	0.93	3.47	1.12
Ograins	0.08	0.38	0.26	1.45	0.46	0.35	1.52	1.01	4.76	1.67	0.34	1.52	1.02	4.77	1.68
Oilseeds	0.20	0.39	0.35	1.02	0.39	0.95	1.65	1.40	3.54	1.51	0.94	1.65	1.40	3.55	1.51
Rawsugar	0.01	0.54	0.45	3.08	0.56	0.68	2.38	2.00	11.91	2.50	0.67	2.38	2.00	11.92	2.50
Vegfrunuts	0.10	0.23	0.21	1.13	0.30	0.55	1.01	0.89	3.58	1.11	0.55	1.01	0.89	3.59	1.11
Catshp	0.23	0.31	0.97	1.22	0.72	0.95	1.20	3.82	3.84	2.75	0.94	1.20	3.83	3.85	2.75
Pigspoultry	0.11	0.33	0.28	1.24	0.44	0.51	1.25	1.08	3.97	1.54	0.50	1.25	1.08	3.98	1.55
Rawmilk	0.01	0.60	0.37	2.54	0.59	0.14	2.39	1.45	8.51	2.17	0.14	2.40	1.46	8.52	2.17
AGRIC	0.12	0.38	0.36	1.32	0.43	0.56	1.51	1.43	4.35	1.59	0.55	1.51	1.43	4.35	1.59
Red meat	0.11	0.17	0.32	0.27	0.24	0.47	0.64	1.25	0.86	0.92	0.45	0.64	1.25	0.87	0.92
White meat	0.08	0.20	0.15	0.46	0.15	0.34	0.74	0.59	1.49	0.55	0.32	0.74	0.59	1.50	0.55
Dairy	0.01	0.19	0.09	0.06	0.11	0.08	0.75	0.34	0.24	0.41	0.06	0.75	0.34	0.25	0.41
Sugar	−0.01	0.09	0.04	−0.01	0.01	0.07	0.42	0.20	0.07	0.10	0.05	0.42	0.21	0.08	0.10
Vegoilsfats	0.01	0.06	0.16	−0.12	−0.10	0.03	0.23	0.64	−0.39	−0.28	0.00	0.23	0.64	−0.38	−0.26
FOOD	0.02	0.09	0.07	0.15	0.07	0.09	0.34	0.25	0.50	0.26	0.06	0.34	0.26	0.51	0.26
NATENE	0.00	0.00	0.00	−0.06	−0.01	0.00	0.00	−0.02	−0.20	−0.03	−0.01	0.00	−0.02	−0.20	−0.03
MANU	0.00	0.00	−0.01	−0.09	−0.01	0.01	−0.01	−0.04	−0.29	−0.05	−0.02	−0.01	−0.03	−0.28	−0.05
SERV	0.01	0.00	−0.01	−0.12	−0.01	0.02	0.00	−0.05	−0.36	−0.04	−0.02	0.00	−0.04	−0.35	−0.04

Germany, France), the resulting increase in domestic demand leads to slight rises in services output. Using a similar logic, in EU regions where real income falls (e.g., Poland), services output also contracts. In the UK, since the services sector is relatively prominent as a proportion of GDP, real income rises in scenarios 1 and 2 lead to real growth improvements, factor price rises and concomitant real exchange rate appreciations (not shown). In scenario 3, real income in the UK falls very slightly, such that services sector output remains flat and non-land factor returns fall.[20]

The manufacturing sector is relatively more 'unskilled labour' intensive, whilst it also faces greater import competition. In those EU member states which undergo real income increases, demand rises lead to relatively stronger import substitution effects accompanied by a lower domestic supply response. In the EU members which are relatively worse off, manufacturing output improves slightly. For the EU28 the overall impact on manufacturing and services is minimal given that general equilibrium (i.e., resource reallocation) ripple effects from a 'small' sector such as agriculture are muted.

Conclusions

This study examines the potential trade and welfare implications arising from a reform to the European Union's common agricultural policy budget. A positive finding is that the cuts in the budget under all scenarios have relatively limited impacts on third countries, or indeed EU agricultural output. To a large extent, this is to be expected given the assumption of production neutral behaviour with respect to the single farm payment. In the literature there are possible channels coupling farmer production decisions to the single farm payment (Moro and Sckokai, 2013), although there also remains considerable parametric uncertainty regarding the appropriate 'coupling factor'. Consequently, changes in agricultural output are mainly linked to productivity effects arising from changing pillar 2 expenditures.

As a further observation, the complex system of intra-community transfers via the budget implies that policy induced changes to agricultural expenditure limits have, at the margin, impacts on intra-EU income transfers, real incomes and trade balances. Given the redistributive nature of CAP support, in relative terms the largest winners (losers) from CAP budget cuts are the Netherlands and Germany (Romania and Poland). Whilst the UK is found to be a net CAP budget contributor even with the rebate, the biggest gains from reducing the UK rebate (scenario 3) accrue to France – a result which underlines France's strong opposition to this mechanism.

As is the case in all empirical studies, a number of caveats should be observed. Firstly, no assumption is made regarding how, for example, potential taxpayer savings (losses) from budget reductions are allocated within national economies. In the current study, this is manifested as a rise (fall) in aggregate savings and domestic demand. Other possibilities that could be explored, however, are the diversion of funds to research and development activities, or perhaps as a subsidy to labour. Alternative assumptions will clearly have different implications on economic performance. Secondly, the elasticity of productivity change to pillar 2 expenditure changes is currently based on a limited pool of literature and informed qualitative expectation. Although further literature is emerging (Mary, 2013), additional research is necessary. Related to this is the potential reverse 'crowding out effect' from the withdrawal of publically financed pillar 2 investments. In other words, the extent to which private investment could mitigate productivity reductions, particularly those observed in the newer member states. Finally, the welfare results reported here for the European Union are biased by the interpretation of the endowment effect. Whilst marginal agricultural land which falls out of production registers as a loss to the economy, there is no mitigating mechanism for its possible uptake in non-agricultural uses (e.g., forestry, construction).

As a final remark, the compromise budget agreement, consistent with scenario 1 of this study, was the result of months of political horse-trading representing a broad spectrum of vested interests across the European Union member states. In this context, that an eleventh hour political agreement was reached at all should be hailed as an achievement. Notwithstanding, with a budget review scheduled for 2016 and the economic crisis exposing cracks within a multi-speed trading bloc, it is quite possible that the current agreement may only serve as a short term stop-gap prior to a further round of tough negotiations.

Disclaimer

The views expressed are purely those of the author and may not in any circumstances be regarded as stating an official position of the European Commission.

[20] These observations explain the UK's ToT changes (Table 4) under scenarios 1 to 3.

Acknowledgments

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Appendix A. Database preparation and recalibration

Examining the GTAP database (version 8.1), a first step was to extract a fully detailed categorisation of all agricultural domestic support payments which are allocated across the tax wedges corresponding to the factors of production, output and intermediate inputs. This task served as a starting point for (i) examining the comprehensiveness of the EU domestic support data in GTAP and (ii) designing a detailed CAP policy baseline post-2007 (GTAP benchmark year) targeting detailed payment changes within the specific tax wedges of the GTAP data.

In the GTAP documentation and associated excel spread sheets, Jensen (2010, 2009) splits agricultural support payments for each of the EU27 members following the OECD classification of single commodity transfers (SCT); all commodity transfers (ACT); group commodity transfers (GCT) and other transfer payments (OTP). Within each of these 4 classifications, one can find a rich but not exhaustive array of different support payments (i.e., 'decoupled'; 'coupled direct payments'; 'market measures'; 'additional direct transfers'; 'other EAGF payments'; 'agri-monetary transfers'; 'rural development Axis 1 and 2 payments' and 'national payments').

SCTs are commodity specific support payments, so it is possible to see the exact amount of each type of SCT payment which corresponds to each agricultural activity in each EU region in the GTAP database. Unfortunately, by their very nature, one cannot directly extract the value of GCT or ACT type payments by activity. Consequently, to disentangle these values, we followed the approach of Jensen (2010, 2009) by employing detailed output share data for 2007 from Eurostat's economic accounts for agriculture. This yielded a full classification of GCT and ACT agricultural domestic support payments by type, activity and respective GTAP support wedge (i.e., factor subsidy; output subsidy; or intermediate input subsidy). For the purposes of accuracy, all agricultural support payments originating from national governments do not pass through the CAP budget accounting structure. These national payments, which sum to €10,446 million (in 2007 prices at the 2007 €:$ exchange rate (0.7305)), are also identified by GTAP activity and support wedge.

A second step involved cross-checking the output generated in step 1. To accomplish this, the European Commission's principle database for the statistical recording and auditing of CAP payments, known as the Clearance Audit Trail System (CATS) database, is employed. Table A1 shows a summary comparison (aggregated to the EU27) between the CATS data and the GTAP version 8 data in 2007 and complete CATS data for the latest year (2011) at the time the research was conducted.

A comparison of the two datasets reveals that the degree of coverage of pillar 2 payments in the GTAP data is incomplete when compared with the CATS data. In the GTAP database, there is coverage of most Axis 1 (investments in physical and human capital) and Axis 2 (least favoured area and agri-environmental) payments. On the other hand, GTAP data has no coverage of Axis 3 (wider rural development measures), Axis 4 (local development strategies) and Axis 5 (technical assistance). As a result, in the GTAP database, pillar 2 expenditures total €11,510 million, compared with €18,170 million in the CATS dataset. On the other hand, a comparison by payment measure shows that GTAP based expenditures on physical (EU and nationally sourced) and human (nationally sourced) capital exceed those corresponding expenditures recorded in CATS. In the absence of more detailed documentation from GTAP, we can only speculate on the reasons for this. A closer examination of the GTAP data reveals, in some cases, a significant

Table A1
Total Pillar 1 and 2 CAP expenditures (€ millions in current prices).

	GTAP v.8.1 data 2007	CATS data 2007	CATS data 2011
PILLAR 1			
Market measures (05_02)	729.5	729.5	729.5[a]
Decoupled direct payments (05_03_01)	31527.0	31527.0	37970.1
Coupled direct payments (05_03_02)	5510.7	5510.7	1718.8
Additional direct payments (05_03_03)	533.9	533.9	443.2
Other EAGF	245.9	245.9	245.9[a]
Agri-monetary	−14.5	−14.5	−14.5[a]
1. Total PILLAR 1	38532.5	38532.5	41093.0
PILLAR 2 (EU sourced):			
Investment in physical capital	1338.5	872.8	2525.5
Investment in human capacity	31.6	686.7	1043.9
Wider rural development	0.0	337.9	2226.4
LFAs	1169.6	2010.5	1908.6
Agri-environmental measures	1574.5	2823.6	3521.3
2. Sub-total	4114.2	6731.5	11225.7
PILLAR 2 (Nationally sourced):			
Investment in physical capital	1977.8	1600.3	4178.5
Investment in human capacity	1090.0	1077.2	1608.5
Wider rural development	0.0	519.8	3321.5
LFAs	1596.4	3369.2	3305.2
Agri-environmental measures	2731.6	4871.8	5794.3
3. Sub-total	7395.7	11438.4	18208.0
4. Total PILLAR 2	11509.9	18169.9	29433.7
Total CAP expenditure (1 + 4)	50042.5	56702.4	70526.7

[a] Given the nature and small share (approximately 2% of pillar 1) of payments devoted to market measures, other EAGF and agri-monetary payments, these are left unchanged in the baseline and subsequent time period.

incongruence between EU expenditures (small values) and what are supposed to be co-financed national expenditures (large values). This leads us to suspect that in the GTAP data, the national component may include additional independent fiscal measures by member states which have been added to their co-financed expenditures. In the far right hand side column of Table A1, CAP expenditures for 2011 are presented which are employed as a basis for the agricultural baseline of this study. The important point here is the change in the decomposition of CAP support both in terms of the distribution between pillars 1 and 2, as well as the ongoing shift in pillar 1 expenditures toward decoupled support (at the aggregated EU27 level, it is not possible to see the importance of article 68 (recoupled) payments in those member states which use this option (e.g., France, Italy or Spain)).

A third data step is then performed involving a recalibration (Malcolm, 1998) of the existing data flows in the GTAP database. Thus, the first part of the recalibration procedure involved the removal of existing GTAP Axis 1 and 2 payments by sector and region and the insertion of the CATS representation of pillar 2 payments by member state. Thus, 'least favoured area' (LFA) and 'agri-environmental' payments are calibrated as uniform payments to the land factor across all agricultural activities (Nowicki et al., 2009) (see also Appendix 'Pillar 2 payments and productivity effects'). A second part of the recalibration procedure involved the reallocation of decoupled support from all factors (GTAP default setting) to the land factor as a uniform land subsidy rate. In effect, the recalibration of decoupled support assumes that the single farm payment (SFP) is production neutral, excludes cross commodity effects and capitalises the entire SFP into the value of land. Comparing with the standard GTAP model representation, the reduction or removal of this payment produces considerably smaller production falls in agricultural sectors, whilst changes in the SFP are now fully capitalised into the market price of land (Urban et al., 2012). Thirdly, apart from energy and services input subsidies, 'intermediate input subsidies' in the GCT and ACT categories are calibrated as a single uniform subsidy rate for domestic and imported inputs 'i' to the agricultural sectors 'j'. Intermediate input subsidies related to farm services are all inserted on agricultural usage of the 'other business services' sector. Agricultural intermediate input subsidy rates for energy usage (i.e., fuel rebates) are left unchanged in the GTAP database.

Appendix B. Modelling

CAP budget expenditures

In the GTAP data, CAP support payments are traditionally represented as tax wedges between the *agents price* and the *market price*. As noted in Appendix A, the OECD classification of domestic support dictates on which flow (i.e., output, input or endowment) each support payment is paid. In the accompanying GTAP model, these wedges are represented as exogenous *ad valorem* tax 'powers' summarising the ratio of agent to market price. Following the convention of the GTAP database, for input- and factor-based tax powers, a subsidy implies that the price paid by the agent (i.e., farmer) is lower than the market price, whilst on output-tax powers, a subsidy implies that the market or sales price of activity 'j' is lower than the agent (i.e., farm gate) price.

In reality, CAP support payments which are fixed in nominal terms are driven by policy, whilst the standard GTAP treatment incorrectly implies that the level of support received changes with endogenous changes in (pre- and post-tax) prices and quantities, even when the tax power is fixed (Woltjer and Kuiper, 2014). To circumvent this problem, the standard MAGNET treatment draws a direct relation between the (endogenous) percentage changes in the tax power and the (policy driven) change in the CAP payment. In general terms, the percentage change in the output/input/factor tax power (tax_p) is endogenously determined as (lower case letters are 'percentage change' variables and dropping subscripts):

$$\mathrm{VF} \times \mathrm{tax\_}p = 100 \times \mathrm{d\_PAY} - \mathrm{PAY} \times [pm + q] \tag{A.1}$$

where VF is the output/input/factor value flow (in pre-tax prices) upon which the tax is levied and d_PAY is the 'change' in the value of the agricultural payment.[21] The coefficient PAY is the benchmark value of the agricultural payment which is calibrated within the GTAP data output/input/factor tax wedge[22] and pm and q are percentage changes in the market price and quantity in sector 'j', respectively. Thus, in first order terms, the percentage change in the tax power is a function of the change in the agricultural payment, whilst the second term on the right hand side is a correction factor to remove agricultural payment changes owing to endogenous adjustments in quantities and market prices.

In turn, d_PAY is a function of changes in existing agricultural payments calibrated within the GTAP database (d_PAYEXIST) and additional (exogenous) agricultural payment changes (d_PAYNEW) post 2007:

$$\mathrm{d\_PAY} = \mathrm{d\_PAYEXIST} + \mathrm{d\_PAYNEW} \tag{A.2}$$

In addition, d_PAYEXIST is determined as:

$$\mathrm{d\_PAYEXIST} = \left[\frac{\mathrm{PAY}_{t=0}}{100}\right] \times \mathrm{payexist} \tag{A.3}$$

where 'payexist' (exogenous) is the percentage change in existing CAP payments, $\mathrm{PAY}_{t=0}$ is the value of CAP payments in benchmark period 0 which is updated by d_PAY in the next period. This implies that changes in both existing and new agricultural payments in period t become the initial value of agricultural payments in period $t + 1$ (i.e., $\mathrm{PAY}_{t=1}$). Additional accounting equations are implemented to calculate CAP budget payment totals by region.

In the standard MAGNET CAP budget module, pillar 1 expenditure is only represented by *decoupled* payments. In the current paper, the definition of pillar 1 in the CAP budget module has been broadened to include *all* CAP payments. Following the convention in Eqs. (A.1)–(A.3), a modified version of the model code includes changes in payments and percentage changes in tax powers for decoupled and 'other' payments. In the case of decoupled payments, we assign them exclusively to a uniform land tax power across all using agricultural activities 'j' within a region. For remaining payments, an additional index is added to the equations to distinguish the payments by measure (i.e., coupled direct payments, market measures, additional direct transfers, other EAGF payments, agri-monetary transfers), which in turn are linked to their specific output-, input-, and endowment-tax power variables in each agricultural activity 'j'. In those cases where one or more payment measures is linked to the same tax wedge, in first order linear terms, the composite (endogenous) tax wedge is the summation of the percentage changes in the tax powers for each payment measure.[23]

In the MAGNET model, pillar 2 payments are aggregated into five 'classifications' according to the fundamental similarities in their economic mechanisms. Pillar 2 payments on 'agri-environmental schemes' and 'least favoured areas' are tied to the land tax power (Nowicki et al., 2009) following the general approach

[21] Since $x = \mathrm{d}X/X * 100$, then, $X * x = \mathrm{d}X * 100$.

[22] Pillar 2 payments on physical capital, human capital and wider rural development measures do not appear in Eq. (A.1) (see Appendix 'Pillar 2 payments and productivity effects').

[23] In linear terms, the endogenous percentage change in the 'composite' tax power 't' is the ratio of prices p_1 to p_3 ($p_1 = t + p_3$), where $p_1 = t_1 + p_2$, t_1 is the change in tax power corresponding to payment measure 1; $p_2 = t_2 + p_3$, t_2 is the change in tax power corresponding to payment measure 2; and $t = t_1 + t_2$.

described above. Additional pillar 2 expenditures on physical capital, human capital and wider rural development are captured as additional expenditures within the accounting equations of the CAP Budget, but are not linked to any subsidy wedge (see Section 'Pillar 2 payments and productivity effects'). Given the degree of detail within the CATS database, a key point of deviation from the standard MAGNET model is that pillar 2 payments are also split by their source of origin (i.e., EU or national government) in recognition of the co-financed nature of these payments (see Appendix A). Thus, both EU and nationally sourced pillar 2 payments appear in the land subsidy wedge (i.e., least favoured area and agri-environmental payments) and accrue productivity effects (i.e., human capital, physical capital, agri-environmental payments, wider rural development measures), but only EU sourced pillar 2 payments appear in the accounting equations of the CAP budget.

CAP Budget own resources module

In MAGNET, there is no module to account for the own-resources component of the CAP budget. This module constitutes an additional feature of the current study. In line with EU law, 75% of each EU member's tariff revenue (TREV) is collected (the remaining 25% is assigned to administrative costs) to finance the EU Budget, which can be calculated from the GTAP database. In general terms:

$$TREV_s = CAPSHR \times 0.75 \times [VIMPORTM_s - VIMPORTW_s] \quad (A.4)$$

where $IMPORTM_s$ and $IMPORTW_s$ are total imports to EU region 's' at market and world prices, respectively. In this paper, only the CAP component of the EU budget is modelled. To calculate those tariff resources which are channelled from EU member states to cover CAP expenditures, we employ the CAP share of EU budget spending (exogenous variable, CAPSHR). Employing financial framework projections data and own calculations, the benchmark value of CAPSHR is calculated and shocked over the 2007–2020 time horizon (see scenario design). In addition, the EU legislation stipulates the use of value added tax (VAT) contributions to meet EU budget expenditures. In the current study, this source of EU budgetary funding is not included in the model code owing to the incompleteness of the VAT data in the GTAP model.

By summing over all EU sourced (pillars 1 and 2) CAP payments, one calculates the EU-wide cost of the CAP (EUCAPCOST). Calculating total EU tariff revenues by summing $TREV_s$ over all EU regions 's' and subtracting from EUCAPCOST gives the remaining resource cost of the CAP budget (RESOURCE). This shortfall is met by an endogenous EU-wide uniform percentage share of each EU members' GDP (RATE):

$$RATE = \frac{RESOURCE}{EUGDP} \quad (A.5)$$

where EUGDP is calculated from the GTAP macro accounts as:

$$EUGDP = \sum_{s \in EUregions} GDP_s \quad (A.6)$$

Multiplying RATE by the value of GDP in each member state, gives each EU members' GDP contribution ($MSGDP_s$). Thus, for the purposes of accounting consistency, the CAP budget balances (i.e., EU-wide CAP budget payments and revenues are equal).

At the member state level, the following equation applies:

$$NETPOS_s = CAPBUD_s - TREV_s - MSGDP_s + LUMPPAY_s + REBATE_s \quad (A.7)$$

where $NETPOS_s$ is the net CAP budget position of each EU member and $CAPBUD_s$ are the total payments received by each EU member from the CAP budget. Thus, an individual member state may be a net contributor (i.e., $CAPBUD_s < (TREV_s + MSGDP_s)$) or a net beneficiary (i.e., $CAPBUD_s > (TREV_s + MSGDP_s)$). To maintain the identity that regional expenditures must equal regional incomes in the model, the calculation of regional savings by EU member in the benchmark GTAP database is adjusted in accordance with each EU member states' benchmark budgetary position.

In line with the European Council Agreement of February 2013, from 2014 in addition to the Netherlands and Sweden, Denmark also receives an (exogenous) annual lump sum transfer payment ($LUMPPAY_s$). The cost of these intra-budgetary transfers is met endogenously by the remaining member states (negative $LUMPPAY_s$ values) as a function of their value share of EU GDP. Further accounting equations are inserted to consider the UK rebate and subsequent corrections to other member states. In accordance with the EU budgetary agreement, the UK rebate ($REBATE_{UK}$) is calculated as 66% of its net contribution, $NETPOS_{UK}$ (i.e., only when $NETPOS_{UK} < 0$). The (negative) value of $REBATE_s$ for remaining EU members is calculated multiplying their EU GDP value shares by the UK rebate. This calculation is, however, modified to account for the fact that Austria, Germany, the Netherlands and Sweden only pay 25% of their GDP share contribution to the UK's rebate, which is compensated by the remaining EU members in proportion to their EU GDP value shares.

In the 2007 benchmark, the CAP budget applies to EU27 regions. Additional exogenous switch variables are employed to incorporate Croatia both within the CAP Budget own resources, the UK rebate and subsequent member state correction mechanisms (in line with the European Council Agreement of February 2013 on 2014–2020 MFF).

Pillar 2 payments and productivity effects

In the standard MAGNET model, the long list of different rural development (pillar 2) measures are aggregated into groups according to the similarities in the economic mechanisms which underlie them. In short there are five classes of pillar 2 payments: (i) investment in human capital (e.g., vocational training, setting up of young farmers, use of advisory services, etc.); (ii) investment in physical capital (e.g., modernisation of agricultural holdings, infrastructure investments, adding value to agricultural and forestry products, etc.); (iii) agri-environmental payments (e.g., Natura 2000 payments, forest-environment payments, etc.); (iv) least favoured areas (e.g., payments to farmers in mountainous areas); and (v) wider rural development schemes (e.g., diversification into non-agricultural activities; encouragement of rural tourism; village renewal and development, etc.). By their nature, 'agri-environmental schemes' and 'least favoured areas' are directly tied to the land factor (Nowicki et al., 2009), whilst the remaining three classes of pillar 2 payments, which are not linked to any specific factor demand, intermediate input demand or output in the farming sectors, are not calibrated to any subsidy wedge within the GTAP data.

In terms of productivity effects, pillar 2 payments of classes (i), (ii), (iii), and (v) are assumed to incur endogenous output or input productivity effects. Investments in physical capital are posited to lead to increases in productivity in agricultural sectors. Estimates (indirect and direct) of vintage effects of investment in physical capital on output productivity suggest a rate of return of 30% (Nowicki et al., 2009), based on research by Wolff (1996) and Gittleman et al. (2006).

Investments in human capital are assumed to increase output productivity in agricultural sectors. Greater awareness of farming practise leads to (*inter alia*) better use of machinery, improved fertiliser, pesticide and feed application, and more efficient land use (e.g., better timing, producing higher quality products). The assumed productivity parameter of 0.4 is employed in MAGNET based on the research of Evenson (2001), which suggests an

internal rate of return of 40% for the OECD countries. Accordingly, an investment of one euro per unit of physical capital stock increases output productivity by 40%.

As the largest budgetary component of pillar 2, expenditures on agri-environmental measures compensate farmers in return for a more extensive (i.e., less capital and labour intensive production processes) production system. Pufahl and Weiss (2009) show that agri-environmental payments can generate an increase in marginal land use that might otherwise have gone out of production. Following Nowicki et al. (2009), it is assumed in the MAGNET model that labour and capital productivity in agricultural sectors decreases by 5% for every one euro of expenditure on agri-environmental schemes.

Finally, wider rural development schemes encapsulate a broad variety of initiatives to reverse economic and social decline in rural areas by promoting innovation and creating employment opportunities in rural areas, thereby promoting output productivity change not only in agriculture but also in the wider rural economy. By way of assumption (Woltjer and Kuiper, 2014), MAGNET employs the same rate of return as that used for physical capital investments (i.e., 30%).

In modelling terms, output augmenting technical change in agricultural sector 'j' (OA_j) follows an *ad hoc* endogenous specification. Employing CATS data, total expenditures (i.e., EU and nationally sourced) of human capital (HK), physical capital (PK) and wider rural development measures (WID) are inserted as follows (dropping the regional subscripts):

$$OA_j = \Theta \times \left[\frac{HK}{\sum_{k\in AGRIC} VOA_k}\right] + \Phi \times \left[\frac{PK}{\sum_{k\in AGRIC} VK_k}\right] + \Xi \times \left[\frac{WID}{\sum_{k\in TRAD} VOA_k}\right] \quad j \in AGRIC \tag{A.8}$$

where Θ, Φ and Ξ are technical change transfer parameters relating to HK, PK and WID schemes with values of 0.4, 0.3 and 0.3, respectively. Thus, the ratio of HK to the total cost-price value of agricultural output (based on GTAP data) multiplied by Θ, yields the output augmenting technical change in agricultural sector 'j' from HK. The proportion of PK to the total cost-price value of the agricultural capital stock (based on GTAP data) multiplied by Φ, yields the output augmenting technical change in agricultural sector 'j' from PK. Finally, the proportion of WID to the total cost-price value of *all* sectors' output (based on GTAP data) multiplied by Ξ, yields the output augmenting technical change from physical capital expenditures in agricultural sector 'j' from WID.

In the non-primary agricultural sectors, output augmenting technical change is assumed to respond to changing WID expenditures only (dropping the regional subscripts):

$$OA_j = \Xi \times \left[\frac{WID}{\sum_{k\in TRAD} VOA_k}\right] \quad j \in NAGRIC \tag{A.9}$$

In levels terms, the endogenous specification for changes in labour and capital factor 'f' (in the set NLAND) augmenting technical change in agricultural sector 'j' ($FA_{f,j}$) resulting from changes in agri-environmental (AE) pillar 2 payments is given below (dropping the regional subscripts):

$$FA_{f,j} = \Psi \times \left[\frac{AE}{\sum_{i\in NLAND}\sum_{k\in AGRIC} EVFA_{i,k}}\right] \quad f \in NLAND \quad j \in AGRIC \tag{A.10}$$

where Ψ is a technical change transfer parameter relating to changes in agri-environmental pillar 2 expenditures with a value of −0.05. Thus, the ratio of AE payments to the total value of labour and capital factor usage in agriculture (based on GTAP data) multiplied by Ψ, yields the input augmenting technical change from human capital expenditures in agricultural sector 'j'.

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