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Foreword

It is an honour and pleasure that I have been invited to be the guest editor of the second issue of Studies in Agricultural Economics in 2018. This is a thematic issue organised around the future of the Common Agricultural Policy (CAP), the debating of which is already well underway in many different forums around Europe. One of such forums was the 162nd EAAE Seminar, titled ‘The evaluation of new CAP instruments: Lessons learned and the road ahead’, held in Budapest on 26-27 April, 2018, where I was the Head of the Local Organising Committee.

This issue contains selected papers from the seminar together with regularly submitted papers on the topic. The first paper, written by Swinbank, sets the scene and shows how past CAP reforms have been incomplete with high tariffs on selected products distorting resource use in the European agricultural sector, imposing extra costs on European consumers and frustrating overseas suppliers. Swinbank argues that now it is time to complete CAP reform and shows how tariffs, trade and CAP reforms have been interrelated.

The second paper, written by Czyzewski and Matuszczak, also provides a holistic view on the CAP and investigates what rent-seeking behaviour in agricultural policy looks like in Europe. By proposing an original methodology for valuing political rents, their results suggest that traditional rent-seeking behaviour is not valid in the CAP and that historical payments are neither a rational nor a just solution.

In the third paper, Szerletics investigates another important point of the debate on the future of the CAP – the potential impacts of degressivity and capping on European farm structures -by bringing new evidence from Hungary. After reviewing the relevant literature of the topic, data and new evidence shows that placing a cap on direct payments may be causing more harm than good by encouraging farms to split their land in Europe where land use patterns are in any case fragmented (if not dual, in many places).

The fourth paper, written by Wrzaszcz, analyses the effectiveness of greening in Poland by using FADN panel data of 7400 private farms in Poland. This approach is highly needed as evidence on the potential effects of greening is currently scarce in the literature. Results of this paper suggest that Polish farms have adapted well to greening requirements and the new system has not caused production and profitability of Polish farms to decrease in 2015.

The remaining three papers suggest evidence for researchers and policy makers interested in the CAP from an ‘outsider’ point of view. Liu and Ge investigates the beneficiaries of the export tax rebate policy of China through providing evidence from the local fishery sector. By applying a partial equilibrium framework, the authors indicate that although producers’ welfare is increased by export tax rebates, foreign consumers capture most of its welfare benefits. This paper offers a nice potential of new ideas and thoughts interested in the welfare analysis of CAP measures.

Meyer contributes to the analysis of agri-environmental impacts of agricultural policies by analysing the impact of agricultural land use change on lake water quality through evidence coming from Iowa, USA. This paper quantifies the environmental impact of the Farm Bill by using a unique dataset covering fifteen years and hundred lakes. Results suggest that renewable fuel standards decreased lake water quality in Iowa – the approach and methodology used here might also be useful in analysing the environmental impacts of the CAP.

In a short communication, Duchoslav and Asseldonk explores the potential impacts of credit-linked crop index insurance through the case of Mali. Their results suggest that linking crop insurance with credit should not only be beneficial for banks to limit their exposure (on a mandatory basis), but should become beneficial as well for smallholders (in terms of better access to credit, lower interest rates or less required collateral). Their approach, again, might be useful for those working with insurance models in Europe.

On the whole, this special issue well reflects the diversity of the debate on the future of the CAP and it hopefully contributes to a better understanding of the past and future impacts of agricultural policies by bringing examples from inside and outside Europe.

Jámbor Attila
Budapest, July 2018

Alan SWINBANK*

Tariffs, trade, and incomplete CAP reform

The original CAP's high levels of border protection on many products involved a variable import levy bridging the gap between world prices and the EU's much higher minimum import price. The Uruguay Round ended this, but tariffication also meant that subsequent CAP reforms reducing EU levels of domestic market price support would no longer trigger lower tariffs. Moreover the Doha Round's plans for tariff cuts are in abeyance. The consequences are: i) for these products, only preferential suppliers penetrate the EU's protected market; ii) negotiation of Free Trade Areas is made more complicated; and iii) "Brexit" is problematic.

Keywords: Brexit, CAP, Doha, tariffication, Uruguay

JEL classification: Q18

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Introduction

When the common agricultural policy (CAP) was constructed in the 1960s and 70s one distinctive feature, much remarked upon by outside observers, was its high levels of protection against third country imports. For many products a variable import levy bridged the gap between a fluctuating world market price and the EEC's minimum import price.[2] In the Uruguay Round, *tariffication* put a stop to this practice, and modest reductions to the EU's tariff bindings were negotiated.

Tariffication, however, resulted in a compartmentalization of CAP decision-making. No longer were the Directorate-General for Agriculture and the Council of Agriculture Ministers responsible, in the main, for determining border protection as part of the CAP. Instead this role had been ceded to the Directorate-General for External Relations (subsequently DG Trade) and the foreign affairs ministers. Moreover, whilst tariffication meant that subsequent increases in the CAP's levels of domestic market price support would no longer be reflected in increased border protection, equally reductions would no longer automatically trigger lower tariffs.

Successive reforms of the CAP have resulted in further cuts in domestic support, but there have been no offsetting reductions in the EU's farm tariffs, despite concerted efforts in the Doha Round to secure multilateral agreement on tariff cuts. One of the aims of the Doha Round, launched in 2001, in the negotiations on agriculture was to secure: 'substantial improvements in market access; reductions of, with a view to phasing out, all forms of export subsidies; and substantial reductions in trade-distorting domestic support' (WTO, 2001: 3). Initial plans to complete the Round in 2003 were frustrated, but in 2008 an agreement did seem to be within reach that would have involved developed-economy members of the WTO (such as the EU) reducing their highest tariffs on agricultural goods by up to 70% (WTO, 2008).

This paper discusses both the continuing failure of the Doha Round to deliver on those promised tariff reductions, through to, and including the 11th Ministerial Conference in Buenos Aires in December 2017 (*MC11*); and also the EU's reluctance to do so unilaterally. The consequences of this failure to reduce the EU's tariffs on these highly protected CAP products are profound, as: i) only preferential supplies satisfying specific criteria (e.g. rules of origin) can penetrate the EU's protected market, thus reducing the potential gains from trade; ii) negotiation of Free Trade Area (FTA) agreements is made more complicated than might otherwise be the case; and iii) extricating the United Kingdom from the EU ("Brexit") is more problematic.

To explore these issues the article proceeds as follows. First it explains how the EU's old variable import levy mechanism worked, and how tariffication put an end to this practice. Second it argues that tariffication resulted in a compartmentalization of EU decision-making, and shows how subsequent CAP reforms have resulted in significant reductions in domestic support, with no offsetting reductions in border protection, despite the aspirations expressed at the launch of the Doha Round in 2001. The third substantive section explores the political economy constraints that limit the actions of the EU's trade negotiators and (seemingly) preclude unilateral tariff reductions. Finally the text explores the political economy consequences of the EU retaining these excessively high tariffs, before concluding.

Variable import levies, and then tariffication

The 'old' CAP of the 1960s and 1970s, certainly as epitomised by the support arrangements for cereals, was dependent upon three key policy measures: high levels of border protection to stop cheap imports accessing the EU and undercutting EU market prices; sale of products into intervention at guaranteed prices should domestic prices weaken;

[1] A first draft of this paper was prepared for the 162nd EAAE Seminar 'The evaluation of new CAP instruments: Lessons learned and the road ahead'. Drafting began when the author was a Visiting Fellow in the Centre for European Studies at the Australian National University in Canberra. The financial support of the Centre, and the hospitality of its members, is gratefully acknowledged. The paper has benefitted from helpful discussions with Carsten Daugbjerg, and the comments of two anonymous referees. The author, however, retains sole responsibility for any errors, omissions, or misrepresentations.

[2] The European Economic Community (EEC) of the 1960s and 1970s has evolved into today's European Union (EU). In this paper where it seemed most appropriate for the flow of the text, the acronym EEC is used, but elsewhere EU is used as the default without attempting to correctly specify the evolution from EEC to EU.

and payment of export subsidies (called export refunds by the EU) to encourage traders to sell surplus products to third country markets. As a result EU market prices were often well in excess of world market prices (for examples see Ritson, 1997: 3). The basic, if flawed, rationale for this policy was that, by raising farm-gate prices, and hence farm *revenues*, farm *incomes* would be boosted too. But small farmers, with little to sell, would not have much gain, whereas larger farmers with more sales would do disproportionately well; farm *costs* would tend to rise and absorb much of the increase in farm revenues, in particular the resultant increase in land prices would benefit landowners rather than tenant farmers; and a larger population would be retained on the farm, thus depressing 'the individual earnings of persons engaged in agriculture'.

The international community's ire frequently focussed on the disruptive impact of the EU's export subsidies: indeed by the mid-1980s the USA and the EU were engaged in an export subsidy war in which each used taxpayers' money to try to expand their export markets. As a USDA report acknowledged, the purpose of the Export Enhancement Program of 1985 was 'to aggressively recapture lost markets' (Porter & Bowers, 1989: 19). However, the system of market price support would have been impossible to maintain had border protection not kept cheap imports out of the EU's protected market. Moreover, the insulating effect of the EU's variable import levy was insidious, not only blocking access to its protected market from more competitive overseas suppliers, but also tending to create price instability on world markets (see Johnson (1975) for a discussion of the likely impact of national price stabilisation schemes).

Dam's extensive review of the EEC's emerging support arrangements for cereals clearly identified how the variable import levy would work:

'The essential idea is to set in advance the desired internal price ... . The import levy is then varied as often and as much as necessary to make up the difference between the lowest price on the world market and the target price. … The variable levy has some dramatic economic effects for a deficit area. It places the entire burden of adjustment to variations in local supply and demand on third-country suppliers. No matter what quantity is produced (short of a surplus) or demanded locally, domestic suppliers receive the promised prices.' (Dam, 1967: 217-8).

In the annual farm price review under the 'old' CAP the Council of Ministers set support prices for the following year (Harris & Swinbank, 1978). By way of example, the evolution of support prices for sugar for the period 1972/3-1976/7 is shown in Table 1. Annually, on a proposal from the Commission, the Council of Ministers fixed both a common intervention, and a threshold (*i.e. minimum import*), price for white sugar, as reported in the Table, although with booming world commodity prices in 1974 a second round of price fixing took place. Over this period the threshold price for sugar was being set some 16/17 per cent above the common intervention price.

Table 1: Intervention and Threshold Prices for Sugar, 1972/3 to 1976/7 (Units of account per tonne*).

	1973/4	1974/5	1974/5**	1975/6
Common Intervention Price	235.7	252.2	264.8	304.5
Threshold Price	276.0	294.7	308.0	355.2
Council Regulation No.:	1637/73	1600/74	2496/74 & 2518/74***	660/74

* This unit of account is not directly comparable with later units. See Ritson & Swinbank (1997)
** A second increase within the year, from 7 October 1974
*** A Commission, rather than Council, Regulation
Source: Regulations published in the *Official Journal of the European Communities*

Tariffication, a central plank of the Uruguay Round *Agreement on Agriculture* (Daugbjerg & Swinbank, 2009: 55-6), changed all that. The old systems of border protection – not only the EU's variable import levy, but other countries' protective mechanisms as well – created uncertainty for traders, and they could not readily be subjected to bilateral concessions on tariff reductions in trade negotiations. Consequently the Uruguay Round negotiators decided that all existing systems of border protection would be converted into conventional tariffs (fixed in either *specific* or *ad valorem* terms) by computing the difference between a representative internal price with an appropriate external price over the 'base period' 1986–8. These tariffs would be *bound*: that is they became part of the country's WTO Schedule of Commitments and could not be increased without the consent of other WTO Members in accordance with GATT Article XXVIII procedures. Moreover, as part of the Uruguay Round agreements, developed countries agreed to reduce these bound tariffs by 36% on average, over a six-year implementation period, and by no less than 15% for any particular tariff line. The EU also agreed additional constraints on the tariffs it would charge on cereals (and, at the time, husked rice) to ensure that the duty-paid import price for cereals would not exceed 155% of the effective domestic support price (Swinbank, 2017: 4). WTO Members can charge lower tariffs than these bound rates (i.e. *applied* tariffs), but whatever tariff is charged has to be applied on a most-favoured-nation (MFN) basis.[3]

Countries undertook their own calculations, which were barely scrutinised by other WTO negotiators in the run-up to the meeting in Marrakesh in April 1994 that finalised the round. Thus, for white (refined) sugar, the EU declared a tariff equivalent of 524 ecu per tonne, and committed to reduce this by 20 per cent to reach a new bound rate of 419 ecu per tonne in 2000 (Swinbank, 2004).[4] The maths that underpinned this determination is interesting: the internal support price for white sugar over the base period (1986-8) was said to be 719 ecu per tonne, from which was subtracted an external price of 195 ecu per tonne.

In closing this section it is important to make two points. First, that tariffication, and the limited tariff reductions agreed in the Uruguay Round, resulted in very high tariffs

[3] GATT Article I provides for most-favoured nation (MFN) treatment in that no WTO Member is to receive treatment less advantageous than that offered to the most favoured nation, except in three circumstances: i) in a Free Trade Area (FTA) or Customs Union sanctioned by GATT Article XXIV; ii) when preferential access is offered to developing countries, as in a General System of Preferences (GSP); or iii) when country-specific tariff rate quotas (TRQs) were grandfathered into Members' Schedules of Commitments at the conclusion of the Uruguay Round.

[4] This ecu (European Currency Unit) translates directly into today's euro (€).

on a number of CAP products: €419 per tonne in the case of white sugar cited above. Second, the EU's border protection on agricultural products was now fixed. The displaced variable import levy had automatically increased as support prices went up, and similarly might be expected to have decreased had support prices been cut. But that link was now broken. Indeed, as outlined below, despite significant reductions in the EU's support price for white sugar, the MFN tariff remains at a prohibitively high €419 per tonne, rather like the stranded carcass of a beached whale.

In 2014 about 70% by value of the EU's agri-food imports were traded under the WTO's MFN regime, with the remainder under concessional schemes for developing countries and FTA agreements. Of that 70%, some 43 percentage points came in over a zero MFN tariff (European Commission, 2015). This is not particularly surprising: it included tropical beverages (such as tea, coffee and cocoa), soybeans, and some cereals subject to a tariff suspension. The tensions discussed in this article focus on the 20% of agri-food imports in 2014 that paid the full MFN tariff, and those that failed to penetrate the EU's market because MFN tariffs for beef, dairy products, sugar, etc., were prohibitively high.

CAP reform and the failure of Doha

The 1992 MacSharry Reform was in part prompted by impasse in the Uruguay Round, but it then gave the EU enough policy leeway to accept the constraints of the *Agreement on Agriculture* in 1994: a document that had been crafted with the EU's "reformed" CAP in mind (Daugbjerg & Swinbank, 2009). The 1992 deal reduced support prices for cereals and beef, and introduced partially decoupled – taxpayer-funded – payments to compensate farmers for their implied revenue loss, *but it did not* alter the basic market-price support arrangements, and the variable import levy mechanism. Thus Regulation 1762/92, setting out the new support arrangements for cereals, progressively lowered the threshold price. In the currency unit of the time, it was set 45 ecu per tonne higher than the target price for each of the 1993/94, 1994/95, 1995/96, and subsequent marketing years (Council of the European Communities, 1992: Article 3).

Tariffication was implemented later, after the Marrakech Agreement was signed in April 1994. As the European Commission explained in proposing the changes:

'The fundamental change introduced by the new import arrangements is the replacement of variable charges (levies, compensatory amounts, etc.) and other types of non-tariff import restrictions … by stable, degressive tariffs. The introduction of such tariffs will be effected, in legal terms, by means of a suitable amendment to the Common Customs Tariff … . The replacement of variable charges by the CCT duties implies the repeal of all the rules which refer to their calculation, i.e. in particular all provisions on the fixing of threshold prices, reference prices, etc. and the rules laid down for the calculation of variable charges applying to derived products' (Commission of the European Communities, 1994: 35).

Accordingly, in December 1994, agriculture ministers repealed the core CAP provisions fixing threshold prices and determining variable import levies (Council of the European Union, 1994).[5] Tariffication was adopted with far less media publicity, and farm lobby opposition, than had been evident in the long debate over the MacSharry package.

Tariffication severed the formal link that had previously existed between the import tax charged and levels of domestic market price support. This became evident in the *Agenda 2000* CAP reform, when some domestic support prices were reduced, but without any offsetting reductions in tariffs. As Swinbank (1999: 398) observed: 'It is conceivable that in the years to come, CAP reform will entirely remove domestic support and export subsidies, and yet high import tariffs could be retained.' Indeed, successive "reforms" of the CAP have further reduced domestic support, but there has never been a compensating reduction in tariffs (or even a proposal to reduce MFN tariffs). The cumulative impact this has had can readily be illustrated for butter and sugar, as presented in Table 2.

Table 2: Butter and White Sugar: €/tonne.

	Intervention Price for 1992/3*	Support Price in 2017	MFN Tariff from 2000	Within-quota TRQ Tariff**
Butter	3,535.3	2,463.9	1,896	700
White Sugar	640.1	404.4	419.0	98.0

* As reported in (European Commission, 1994: T61 & T67), and then converted by the author into today's euro (€) by applying the coefficient 1.207509 to the support prices reported at the time
** For butter, the TRQ extended to New Zealand; for sugar, the so-called CXL TRQ
Source: Ritson & Swinbank, 1997; WTO (2016), Certification of Modifications and Rectifications to Schedule CLXXIII – European Union, WT/Let/1220 (Geneva: WTO); Regulation 1308/2013.

Thus after the farm price review determining support prices for the 1992/3 marketing year, intervention prices for these products were €3,535.3 per tonne for butter and €640.1 for sugar, as reported in Table 2. Tariffication, and the limited tariff reductions agreed in the Uruguay Round, resulted in the bound tariffs of €1,896 and €419 per tonne (for butter and white sugar respectively) that have applied from 2000 until the present. These were formidably – indeed prohibitively – high tariffs for MFN suppliers to pay. In the case of sugar, some developing countries had (and still have) access to the EU market with a zero duty, and other suppliers have since secured limited Tariff Rate Quota (TRQ) access paying a within-quota tariff of €98 per tonne (so-called CXL sugar). New Zealand has access to a country-specific TRQ to access the EU's butter market, at a within-quota tariff of €700 per tonne, but no longer fully avails itself of this opportunity.

The sugar regime was excluded from Ray MacSharry's CAP reform, and only modest reductions in support prices for dairy products were achieved. A reform of the dairy regime was agreed in principle in 1999 (as part of *Agenda 2000*), but not implemented until the Fischler Reform of 2003. This reduced the 2003 support price of €3,282.0 per tonne by 25 per cent to €2,463.9 in 2007, where it has remained ever since. As there was no corresponding reduction in either the MFN tariff, or New Zealand's preferential rate, the net effect was to increase by €818 the element of redundant "protection" in the tariff, and eliminate New Zealand's tariff advantage. As

[5] Some border measures do, however, remain part of the CAP. This Regulation also dealt with the need to constrain the deployment of export refunds to comply with WTO limits.

the tide retreated the stranded whale carcass was left far from the sea!

For sugar, the reforms did not kick in until 2005/6, following a WTO Dispute Settlement case in which the EU had been found to be exceeding WTO limits on its exports of subsidised sugar (Ackrill & Kay, 2011). This "reform" brought the EU's support price for white sugar down by 36 per cent, from €631.9 to €404.4 per tonne. Consequently the MFN tariff on sugar is now *greater* than the official support price.

The EU has from time to time suspended its import duties on farm products: for example for cereals in 2007 as a 'reaction to the exceptionally tight situation on the cereals markets and the record price levels' (European Commission, 2007), or the supply difficulties faced for industrial (non-food) uses of sugar (Noble, 2012: 21). The EU's *Everything but Arms* initiative, and a number of FTAs, have opened-up the EU's market to selected suppliers; and some limited adjustments have been made to tariffs and Tariff Rate Quotas in its Schedule of Commitments lodged with the WTO as a result of EU enlargement and other renegotiations of particular tariff lines. But, in the main, its *bound* tariffs are unchanged from those determined in the Uruguay Round, and the *applied* tariffs it charges on a MFN basis remain aligned with its bound rates.

… and the failure of Doha

Meanwhile the Doha Round had trundled on. The first skirmishes had occurred as WTO Members prepared for their 3rd Ministerial meeting in Seattle in late 1999. That September the EU's Council of farm ministers had discussed the forthcoming negotiations. Whilst affirming their commitment to the *European Model of Agriculture*, they conceded that: 'The European Union … is prepared to negotiate for lowering trade barriers in agriculture … . However, it must also obtain, as a counterpart, improvements in market opportunities for its exporters' (Council of the European Union, 1999).

The Seattle Ministerial, however, did not result in the expected launch of a Millennium Round; and it was not until 2001 that the *Doha Development Agenda* (DDA) – the Doha Round – got underway (WTO, 2001). The EU's basic approach was still defensive. In January 2003 the EU rejected the more ambitious proposals for tariff reductions advocated by the USA and the Cairns Group,[6] and proposed instead a repeat of the Uruguay Round formula: 'an overall average tariff reduction of 36% and a minimum reduction per tariff line of 15%' (European Commission, 2003). This was rather less generous than that negotiated in the previous round however, for a 36 per cent reduction of a lower base would have produced a smaller reduction in absolute terms.

In fairness to the EU it should be noted that the timing was not propitious. The Doha timetable had envisaged that the "modalities" for agriculture (i.e. a fairly detailed blueprint for the final agreement) should be established by 31 March 2003 (WTO, 2001: 3), and the chair of the agricultural negotiating committee was eager to receive input from WTO Members so that the first draft modalities document could be written. Although the EU's Commissioner for Agriculture and Rural Affairs, Franz Fischler, had launched an ambitious *Mid-term Review* of the *Agenda 2000* reform package – which in the summer of 2003 would be enacted as the first phase of the Fischler Reforms (Cunha & Swinbank, 2011) – this was not yet the EU's confirmed, let alone official, policy. Consequently the EU was not yet in a position to make a more ambitious offer to its WTO partners.

The Fischler Reform, further decoupling support for key arable and livestock products, and the extension of this decoupling principle to most other products in 2004/5, including the sugar reform overseen by Marian Fischer-Boel, and her "Health Check" Reform concluded in November 2008, fundamentally changed the EU's circumstances and hence its freedom of manoeuvre in the Doha negotiations (Daugbjerg & Swinbank, 2011). Brief mention should perhaps be made of the most recent recalibration of the CAP, to configure the policy for the post-2013 period, but by then WTO pressures were no longer a force capable of driving CAP reform (Swinbank, 2015).[7]

In none of these reforms had it ever been suggested that farm ministers should also enact reductions in border protection as part of the package. And that is true of the European Commission's latest thoughts on a post-2020 CAP. In its discussion paper on *The Future of Food and Farming* the European Commission (2017: 25) makes only one (passing) reference to the WTO, followed by one mention of imports when commenting: 'it cannot be ignored that *specific agricultural sectors cannot withstand full trade liberalisation and unfettered competition with imports*. We therefore need to continue to duly recognise and reflect the sensitivity of the products in question in trade negotiations and explore ways how to *address the geographical imbalances* of advantages and disadvantages that affect the farm sector within the Union as a result of EU trade agreements' (emphasis in the original).

By 2008, with soaring prices on world commodity markets (Piesse & Thirtle, 2009) the EU was able to complete its switch from a defensive to an offensive stance in the WTO. This new confidence could already be seen in 2003. Then the Council had declared: 'This reform is … a message to our trading partners …. It signifies a major departure from trade-distorting agricultural support, a progressive further reduction of export subsidies, a reasonable balance between domestic production and preferential market access, and a new balance between internal production and market opening.' But it also stressed that the bargaining process was still in play: 'the margin of manoeuvre provided by this reform in the DDA can only be used on condition of equivalent agricultural concessions from our WTO partners. … Europe has done its part. It is now up to others to do theirs' (Council of the European Union, 2003: 3-4).

Despite this optimism, and an ill-fated venture with the USA to influence the outcome of the negotiations, the Cancún Ministerial in September 2003 ended in failure; with the EU's stance on agriculture probably a contributory factor

[6] A group of like-minded states led by Australia that took its name from the coastal resort in Queensland, Australia (Kenyon & Lee, 2006).

[7] Swinnen (2015: 4) writes: 'The question with the 2013 CAP decisions is not so much whether they are radical reforms (the consensus on this is "no"), but whether they are captured appropriately by the term 'reforms' at all'.

(see for example Bhagwati, 2004). In debriefing the European Parliament, the EU's Trade Commissioner concluded that the Round was: 'if not dead then certainly in intensive care' (Lamy, 2003). Bhagwati (2004: 55), however, considered the outcome 'more of a hiccup than a permanent end to the Doha process.'

The subsequent trajectory of the negotiations was dramatic and convoluted, but by June 2008 a fairly detailed *Revised Draft Modalities for Agriculture* was on the table (see WTO, 2008, 'Rev.4', for the final December 2008 draft of this text). In conceding that the negotiators had failed to achieve the hoped-for breakthrough, Pascal Lamy (2008) – by now the WTO's Director-General – did claim that 'from a technical point of view, the issues are not intractable. In fact *[he continued]* from a purely technical perspective, you are not that far from an agreement on those issues. The bad news is that individual positions – and the position overall – have not changed significantly.'

Successive CAP reforms had meant – according to the EU – that most of its domestic support payments were no longer trade distorting, and accordingly it believed it would face no further constraints if the tighter limits on trade distorting support envisaged in Rev.4 were implemented.[8] A series of reductions in intervention and other domestic market price support mechanisms, combined with the effects of inflation and the buoyant world market prices being experienced in 2008, meant the EU could now envisage a ban on the use of export subsidies: indeed it had committed to that outcome in Hong Kong in 2005.

With EU farmers no longer reliant on market price support, and the EU able to countenance the demise of the export subsidy regime, the final element of CAP reform – removal of its excessively high border protection inherited from the 'old' CAP of the 1980s – was surely feasible. Rev.4 had proposed a 'tiered formula' for tariff reductions, with developed countries' highest tariffs being reduced by up to 70 per cent over a five-year period (WTO, 2008: 14).

After 2008 WTO negotiators switched their emphasis from the *Single Undertaking* – the understanding that nothing could be agreed until everything was agreed – which had successfully underpinned the Uruguay Round, to a more piecemeal approach. In Hong Kong in 2005 ministers had already agreed – in the context of the Single Undertaking – to the 'elimination of all forms of export subsidies' (WTO, 2005: 2); but then in Nairobi in 2015, no longer bound by the Single Undertaking, it was decided that 'Developed Members' would 'immediately eliminate their remaining scheduled export subsidy entitlements' (WTO, 2015: 2) – although, on closer reading, 'immediate' meant by 2020 for some products.

Although some WTO Members had hoped that some progress could be made on the agriculture dossier at their 11th Ministerial Conference (*MC11*) in December 2017, including a tightening of disciplines on domestic support, this proved impossible (Bridges, 2017). There was certainly no movement on agricultural tariffs, in part because of continued disagreement over a Special Safeguard Mechanism (SSM) to benefit developing countries. Indeed, some months earlier the Special Agriculture Committee chair had reported 'that a substantial outcome on market access is not feasible for MC11' (WTO, 2017a).

Institutional and political economy constraints

Two broad sets of questions emerge from the foregoing discussion. First if, as suggested above, WTO Members were close to an agreement on agriculture in 2008, why was it not possible to conclude the deal; and secondly why, with adherence to the Single Undertaking undermined by subsequent Ministerial decisions, is an agreement to reduce agricultural tariffs still elusive? Had WTO Ministers agreed such a package, the EU – committed as it says it is to a rules-based system of international trade – would presumably have complied.[9]

Second, if the Doha Round process has faltered, and the EU is in a position to unilaterally reduce its excessively high MFN tariffs on key CAP products (for example beef and sugar), why does it not do so? As discussed in the next section, these high tariffs are now an impediment to the pursuit of its wider trade agenda, so why does the EU persist?

Quite why the Doha Round has (as yet) failed to deliver on its initial promise of major cuts in agricultural tariffs, and a significant tightening of the disciplines written into the Uruguay Round *Agreement on Agriculture* apart from the 2015 decision to eliminate export subsidies, is a topic that will exercise scholars for years to come, and will not be discussed here. All that can be offered is two brief, tentative, observations.

First that in an organisation (of 160+ members) built on consensus, whose *modus operandi* is based on a balanced exchange of "concessions" across a complex array of issues, agreement is intrinsically problematic, unless some outside pressure can force change. The USA and the EU, it might be argued, managed this in the Uruguay Round by terminating their membership of GATT 1947, together with all their obligations to GATT's other Contracting Parties. In its place they set up a new international trade agreement – the WTO – and invited the other members of the old GATT to join, provided they accepted the whole package of WTO agreements as a Single Undertaking, which they all did (Daugbjerg & Swinbank, 2009: 90-3; Steinberg, 2002).

The USA and the EU no longer have hegemonic powers to coerce WTO members, and it is difficult to envisage a repeat of the American and European Uruguay Round ploy. The USA is still however a major force in the WTO, and as such does exercise veto powers. Thus a second factor explaining the *current* impasse is the stance of President Donald Trump's administration. In a frank discussion at the Center for Strategic and International Studies (2017) in September 2017, prior to the WTO Ministerial, the United States Trade Representative Robert Lighthizer made clear

8 In WTO jargon, support that had previously been classified as Amber or Blue Box support had now been switched into the Green Box. See Daugbjerg & Swinbank (2009: 59-62) for an explanation of Amber, Blue and Green Boxes. Whether the revised payment systems could legitimately be defended as Green Box support is a moot point.

9 The EU has for example implemented the decision to eliminate export subsidies (WTO, 2017b).

the USA's lack of enthusiasm for multilateral, as opposed to bilateral, trade agreements, its distrust of the WTO's Dispute Settlement procedures, and predicted that 'it's unlikely that the ministerial in Buenos Aires is going to lead to negotiated outcomes'. Without American backing the ministerial was unlikely to make substantive process. Indeed, 'Ministers were unable to reach consensus on a ministerial declaration, despite multiple drafts being circulated … . Instead, ministerial conference chair Susana Malcorra issued a summary of the week's discussions under her own responsibility' (Bridges, 2017).

The second question posed above was why, if the EU is in a position to unilaterally reduce its excessively high MFN tariffs on many CAP products, it does not do so? There are probably several parts to the answer: the compartmentalization of decision-making coupled with the mercantilist traditions of trade negotiators; political economy constraints with weak consumer voices no match for a well-resourced farm lobby (dispersed costs *versus* concentrated benefits); and the belief that preference erosion would weaken the existing benefits enjoyed by the EU's preferential suppliers and reduce the EU's bargaining position in future FTA negotiations.

The compartmentalization of decision-making following tariffication, shifting the forum from agriculture to trade, has been outlined above. The Directorate-General for Agriculture and Rural Development no longer has the responsibility, or authority, to fix (most) import taxes, as it did prior to 1995. The common commercial policy is one of the EU's exclusive competences, vested in the European Commission, with DG Trade 'the EU's prime negotiator and guardian of an effectively implemented EU trade policy' (DG Trade, 2017). (The Commissioner for Agriculture and Rural Development also plays an active role in trade negotiations.) Trade negotiators are loath to unilaterally allow increased market access to domestic markets if that improved access is unlikely to be reciprocated in some form – "concessions" in the trading partner's tariff schedule, for example. Moreover, even if negotiators in the stalled Doha Round negotiations saw little scope for a mutual exchange of "concessions", those tariff barriers could still be useful bargaining chips in future multilateral and bilateral trade talks.

Consequences: preferences, free trade areas, and Bexit

Standard economic trade theory predicts that high tariffs restricting access to the EU's market will impose costs (higher prices, and a reduced range of available products) on European consumers and the wider economy. Access, in the main, will be limited to suppliers that have preferential agreements, be they generic schemes available to developing countries, FTAs, or country-specific TRQs grandfathered into the EU's Schedule of Commitments in the Uruguay Round. Even if, by chance, preferential access has been granted to the world's lowest cost suppliers (and often not!), the gains from trade will be abated by the additional customs procedures needed to check rules of origin, and TRQs may limit the volume supplied.

The EU's protective tariffs on agricultural products are not *fully* reflected in EU market prices, particularly for those products for which the EU has emerged as a net-exporter, but some protective effect (which the farm lobby welcomes) remains. Third countries that have preferential access to these protected markets (for beef, sugar, etc.) are likely to bring diplomatic pressure to bear on the EU if they suspect that new trade initiatives will lead to preference erosion, whereas trade partners that do not have comparable access will seek to achieve the same through multilateral (i.e. Doha, or its successor) or bilateral (i.e. FTA) negotiations, or even by challenging the EU's regime in Dispute Settlement proceedings.

When the EU concludes FTAs, particularly with countries that have competitive farm sectors, agricultural commodities and food and drink products are often not fully liberalised. Instead, particular products might be written out of the agreement, or quantities limited by TRQs. Thus the EU-Canada *Comprehensive Economic and Trade Agreement* (CETA) excludes trade in eggs and poultry products, and the duty free import of pork and beef into the EU is limited by TRQs.[10] Access for beef is one of the major requests of Mercosur, which is met by strong resistance by the EU's beef producers (see for example White, 2018). Thus, as with multilateral negotiations, agricultural protectionism can block (or prolong) FTA negotiations.

One egregious example of the distortive effect of the CAP's unreformed agricultural tariffs currently playing out relates to the United Kingdom's attempts to leave the EU, and the issues this raises for trade across the Irish border (Swinbank, 2017 & 2018). In short, what the UK has been arguing for some time is that it is seeking to leave the EU's customs union and single market (and the CAP), giving it the freedom to negotiate FTAs with other countries around the world, whilst maintaining an open – frictionless – border between the Republic of Ireland and Northern Ireland (which is part of the UK) *and* maintaining the integrity of the UK's own internal market. How this particular conundrum will be solved is as yet unclear, but the challenge posed by the CAP's high tariffs is a key concern with which policy makers must grapple.

Concluding comments

In 1992 the EU agreed a package of CAP reform that began a progressive dismantling and decoupling of farm support. In 1995, following a successful conclusion of the Uruguay Round of trade negotiations, agricultural tariffs were first bound, and then reduced. Those bound tariffs are the ones that are still applied on a MFN basis: since that initial bundle of tariff cuts there has been no systematic reduction in the EU's agricultural tariffs despite a succession of CAP reforms. On some key products (beef, sugar, etc.) these MFN tariffs are prohibitively high, and exports to the EU are only commercially feasible if preferential access arrangements are in place.

Past CAP reforms have been incomplete, and high tariffs on selected products continue to protect some farming

[10] CETA explained: http://ec.europa.eu/trade/policy/in-focus/ceta/ceta-explained/ (last accessed 26 February 2018).

activities distorting resource use in the agricultural sector. They impose costs on Europe's consumers and frustrate potential overseas suppliers. Moreover, they complicate the EU's wider trade diplomacy, including the ongoing Brexit negotiations. With the EU's institutions deliberating on the form that the post-2020 CAP should take, perhaps now is the time to complete CAP reform.

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Rent-seeking in agricultural policy revisited: a new look at the Common Agricultural Policy consensus

It is generally believed that agricultural interventionism represents the payment of political rents to farmers. We attempt to show that the concept of political rent known as the rent-seeking theory is not valid for agricultural policy. It is not justified to identify the entire subsidies paid to agriculture as a 'political rent', since political rents cannot be taken to include payments for the supply of public goods or those transfers which compensate for market imperfections. Our work aims firstly to review the concepts of rents and rent-seeking, and to develop a methodology for quantifying political rents in agricultural policy. We perform comparative analyses with the aim of calculating the 'pure political rent', based on the input-output approach for representative farms according to the EU FADN typology and on a decomposition of the Hicks–Moorsteen TFP index for the period 2004-2012 and 27 European Union Member States. The calculations of political rents show that historical payments are neither a rational nor a just solution. No attempts have yet been made in the literature to quantify political rents, even though this might lead to an improvement in the effectiveness of public expenditure. The original methodology is proposed for valuing these items.

Keywords: political rent, rent-seeking, agriculture, treadmill theory

JEL classifications: Q10, Q15, B52

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Introduction

Agricultural interventionism is often justified on ideological grounds, with reference to the objectives of food security, food production self-sufficiency, food safety and natural resource protection. There is a lack of quantitative criteria that might indicate what kind of support should be provided, and to whom, in order to produce benefits in terms of social well-being.

The concept of political rent is defined based on the theory of rent-seeking – but is it conceptually appropriate to contemporary agricultural policy in developed countries? By definition, political rent is inextricably linked to the wastage of resources and to exclusive benefits provided to selected social groups at the expense of others. No attempts have yet been made in the literature to quantify political rents, even though this might lead to an improvement in the effectiveness of public expenditure. This, in our view, is a significant gap.

The present work aims, firstly, to review the concepts of rents and rent-seeking as used in the literature on political economy with regard to their appropriateness to the discussion on European Union (EU) agricultural policy. Secondly, we attempt to develop a methodology for quantifying pure political rents in agricultural policy, and apply it to a comparative analysis of rents from the Common Agricultural Policy (CAP) in the 27 EU Member States in the years 2004-2012. In this way they refute certain stereotypes concerning the CAP, while seeking an answer to the question of what part of the subsidies paid to agriculture in the EU-27 is justified by the concept of payment for public goods or compensation for imperfections in agricultural markets, and what part has no objective justification and represents a pure political rent according to the rent-seeking theory.

This reasoning contributes also to the discussion on the fair level of the CAP payments in different Member States. Per-hectare payments are substantially lower in the countries that joined the EU in 2004 and subsequently. This arrangement is usually supported by the argument that those countries have lower labour costs. However, if policy makers care about equal conditions for competition they should also consider other market imperfections. Some of them manifest in Cochrane's treadmill effects (Cochrane, 1958; Levins and Cochrane, 1996), as well as in the occurrence of public goods. We aim to show how the CAP consensus might be changed by including these effects.

Political rents and rent-seeking: a literature review

Rent-seeking involves a striving by economic entities to obtain benefits (primarily financial or material) by exerting influence on relevant institutions, such as through lobbying[4]. More detailed definitions refer to active rent-seeking, which denotes the expenditure of resources by private firms and interest groups for the purpose of obtaining protective forms of regulation from those in authority (Sztaba, 2002). Two points may be emphasised: firstly, that active rent-seeking includes legal activities and, secondly, that these restrict the free management of resources and to some extent distort competition.

The political rent market is formed on the one hand by those demanding the desired regulations, namely the aforementioned interest groups and manufacturers' and consumers' associations, which expend funds for that purpose and to which particular regulations will bring measurable benefits (such as protection of an internal market, maintenance of prices, approval or non-approval of a particular type of consumer good etc.). The response to that demand is a supply,

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4 The term was first defined by Krueger (1974), although the phenomenon had been considered previously by Tullock (1967).

created by politicians and officials, who 'sell' the regulations over which they have authority, in exchange for political support. Research shows that, fearing loss of electoral support, such persons are willing to intensify their actions relating to rent-seeking (Persson *et al*., 1997; Acemoglu and Robinson, 2000; Acemoglu and Robinson, 2006).

What occurs, then, is a kind of political economic transaction (Zybertowicz, 2010). More concretely, it can be concluded that political rent most often occurs in the form of a transfer of income from certain entities to others, through the use of mechanisms of political power, and not – as is normally the case – through market mechanisms. On a microeconomic approach, the benefits obtained should be considered individual benefits, and the expenditure made should be treated as 'investment'. Hence, if in a democratic society the interests of narrow social groups are carried over to the actions of public authorities, thus providing those groups with exclusive benefits (rents), then this constitutes a political rent (Wilkin, 2012).

From a social standpoint, one may analyse the losses resulting from the unproductive use of resources, and this has been the subject of many theoretical works. From this perspective, the concept of political rent serves to explain why economically-ineffective measures are put into effect by politicians, and then maintained in force, even when they cause obvious harm to the well-being of society. Policy may thus be ineffective in terms of overall well-being (causing non-optimal allocation of resources and distortion of market stimuli) if it provides preferential treatment and potential benefits for specific interest groups that constitute a sufficiently strong electorate (Buchanan *et al*., 1980; Tollison, 1982; Rose-Ackerman, 1997; Schneider and Wagner, 2001; Lee and Tollison, 2011; Aligica and Tarko, 2014).

In this light, it can be claimed that the EU's interventionist agricultural policy provides an example of the existence of political rent. Rent-seeking in EU agriculture, however, does not concern only political lobbying. The claim that subsidies and other instruments of the CAP produce exclusive benefits for farmers at the cost of consumers is somewhat trivial and not entirely accurate. The question would appear to be more complex, as the benefits are not always exclusive, in view of the fact that farmers provide certain public goods, and moreover agricultural producers need to fulfil certain requirements, expending their resources, in order to receive those privileges. According to Tullock, rent-seeking is profitable only in conditions of perfect competition and absence of economies of scale (Tullock, 1980a; Tullock, 1991). If economies of scale are present, the total value of investment required to obtain a political rent is greater than the rent itself (Tullock, 1980b; Tullock, 1991). This would mean that small family farms, which are not able to generate economies of scale in production, are net beneficiaries of political rents, while large farms, for which meeting the CAP's environmental requirements carries a significant alternative cost, may not receive any net rent. In other words, the cost of producing the public goods required in exchange for political rent exceeds the value of the rent (Aligica and Tarko, 2014). The present study aims to establish whether this theory of Tullock is applicable to agriculture in the EU.

In the literature, particularly in the field of political economy, political rents are considered widely, in relation to both the mechanisms for seeking (competing for) them, and their consequences for market processes and well-being. Below we make a review of various theoretical and empirical approaches to the concept of political rent, particularly those which present in a new light the problem of rent-seeking in relation to the EU's CAP. To these approaches may be ascribed the following hypotheses, put forward by the authors cited below: (a) the greater the degree of political competition, the higher the political rents (in other words: small interest groups have greater political strength); (b) market imperfections determine the distribution of political rents; and (c) rent-seeking may be complementary to an increase in production (the *theory of complementarity between rent-seeking and production*).

The fourth thesis refers to the phenomenon of political competition, in the sense of the intensity of rivalry between political parties (Roemer, 2006). The results of a study by Fałkowski and Olper (2014) show clearly that when the level of political competition is higher, the rents paid to agriculture are greater. This positive correlation can be observed in both developing and developed countries. The interpretation of this phenomenon is based, firstly, on an analogy between economic and political competition. Political parties cannot act against the will of the majority, just as producers cannot act against trends in consumption (Becker, 1958; Stigler, 1972). On the other hand, Olson's theory of interest groups states that it is small groups that have greater political power (Olson, 1965), because as interest groups expand, the readiness for collective action declines. This leads to a 'development paradox' (Swinnen *et al.*, 2000; Olper, 2001; Grzelak, 2011): in highly developed countries agriculture makes a relatively small contribution to GDP, but receives relatively large political rents – since the agricultural lobby is small, but well-organised and politically strong (Poczta-Wajda, 2013). Moreover, economic development alters the division of the costs and benefits of support for agriculture (Swinnen, 2009). Per capita costs are distributed between an increasing number of persons employed outside agriculture, entailing a weakening of stimuli to protest against protectionist agricultural policy. At the same time, processes of urbanisation increase demand for services based on the state of the natural environment, which is inevitably connected with rural areas. There is therefore an increase in the utility of the public goods supplied by agriculture, and in readiness to pay for them. Hence retransfers of income to agriculture, even if ineffective from an economic standpoint, are rarely challenged by political groupings (Aidt, 2003). As a result, the observation that in developed countries agriculture is subsidised, while in developing countries it is taxed in net terms, comes to be valid globally.

The best-developed line of research is that concerned with the effect of imperfections of the market (imperfect competition) and of agricultural policy (imperfect implementation) on the distributional effects ('incidence') of agricultural policy (Alston and James, 2002; de Gorter and Swinnen, 2002). It is found that only 20 per cent of total market and price support in agriculture in the OECD countries creates a net surplus in agriculture, while the remainder flows out to related sectors (OECD, 2000), including to landowners (except where individual farms are concerned). This phenomenon is referred to by the authors as a 'surplus drain' from agriculture, and is particularly marked in Central and Eastern European countries. Research conducted in Poland shows that it occurs regardless of the scale of agricultural interventionism, and for example in the period 1990-2003, prior to Poland's accession to the EU, it was equally strong. It can be concluded from this that market imperfections in sectors related to agriculture affect not only the division of political rents to agriculture (if such exist), but also the division of the surplus resulting from increasing agricultural productivity in general.

In view of the importance of this problem and the lack of adequate research in this area, we will devote the remainder of this paper to it. In Western Europe and the USA, where agricultural interventionism has operated continually since the 1950s, studies have confirmed that imperfect competition in the areas of agricultural food processing and the manufacture of means of production and service provision to agriculture has a significant effect on the distribution of political rents (McCorriston and Sheldon, 1991; Salhofer and Schmid, 2004). In turn, it has been shown (Ciaian and Swinnen, 2009) that the net effect of area payments on the profits of single-product farms is negative. For example, in extensive grain production, while farms profit directly from subsidies and indirectly from the increased efficiency resulting from subsidised investments, they lose significantly due to the increase in prices of rent and purchase of land, whose marginal productivity increases, stimulating demand. These losses are dominant in the balance of costs and benefits of decoupled payments. Mixed farms, however, may gain overall, as CAP payments make it easier for them to obtain credit.

Diverging from the main line of thought concerning the decrease in overall well-being due to the payment of political rents is the 'theory of complementarity of rent-seeking and production' (Teng, 2013). Based on a model formalisation, that author challenges the universality of the thesis whereby rent-seeking is identified with a fall in productivity, and proposes a theory in which increased production and rent-seeking are not substitutes. These processes become complementary when the entities seeking rent are also producers, and their production output at the same time constitutes inputs to the rent-seeking effort. It is not easy to apply this generalisation to agriculture (it would be as if farmers paid lobbyists in agricultural products), but certain analogies may be noted. If it is accepted that the 'products' of agriculture include specific public goods, they may also represent a bargaining counter for the agricultural lobby and politicians. In this sense the aforementioned complementarity of production and rent-seeking also arises in agriculture. This is an issue to which we shall return in a later part of our considerations.

The above review of the literature leads to the important conclusion that political rents in agriculture diverge from the essence of the concept of rent-seeking, which is inextricably linked, firstly, to wastage of resources and loss of overall well-being and, secondly, to exclusive benefits obtained by selected social groups at the expense of others.

- If the resources devoted to rent-seeking even partly serve to produce public goods, then that part cannot be regarded as wastage (according to the theory of complementarity of rents and production).
- If the payment of political rents to agriculture results in the delivery of any public goods, then these benefits are not exclusive.
- If market imperfections in sectors related to agriculture cause rents and economic surplus to be captured by other entities, then it is even more the case that these benefits are not exclusive.

The above considerations motivated us to attempt to give a new definition of political rent in agriculture, and to develop a methodology for measuring it. There are no reports in the literature concerning attempts to quantify political rents, even though this might lead to an improvement in the effectiveness of public expenditure. It is generally accepted that agricultural incomes are primarily a result of institutional actions rather than the action of the market (subsidies account for approximately two-thirds of agricultural income in EU Member States on average). For many years, the costs of agricultural production have been estimated to exceed the revenue generated in more than one half of EU Member States, and if it were not for the subsidies paid to farms, agricultural production would become entirely unprofitable (*cf. relationship of decoupled subsidies to agricultural income: according to Farm Accountancy Data Network (FADN) data, in most Member States it is above 0.5 but there are also instances where it exceeds 1*).

We must be aware, however, that the stream of subsidies received by farmers does not in its entirety constitute a political rent as hitherto construed. In this study an attempt is made to evaluate a new category – the 'pure political rent' obtained by agriculture in the various countries of the EU-27. To enable this category to be considered, it is necessary to distinguish within the total pool of subsidies received by a farmer the payment made for public goods generated by the farm, and the part which serves to compensate for the drainage of economic surplus resulting from market imperfections, which causes the prolonged opening of 'price scissors' in agriculture. There are also discussions in the literature concerning the distribution of political rents in the context of market imperfections, for example in relation to land (Ciaian and Swinnen, 2006), credit (Ciaian and Swinnen, 2009), and fishing restrictions (Wilen, 1989, Holzer *et al.*, 2012). The residual amount can then be regarded as a surplus benefit not having any economic justification, and representing the result of rent-seeking.

Methodology for measuring pure political rents

We stated above, based on a review of the literature, that the distribution of political rents is dependent on market imperfections in agriculture and related sectors. Moreover, market imperfections decide not only about the distribution of political rents, but also about the division of economic rents in general. The price flexibility[5] is mainly responsible for draining economic rents from agriculture. It is particu-

[5] Tomek and Robinson (1990) define the price flexibility coefficient as $(\Delta P/P):(\Delta Q/Q)$, where P denotes prices and Q output.

larly characteristic of the sector of agricultural raw materials according to the concept of agribusiness of Davis and Goldberg (1957). Also, Cochrane (1958) introduced the notion that farmers are on a treadmill which, in spite of their constant efforts to improve factors productivity (TFP), wears away any profits that might result. The point of departure for Cochrane was the statement that it is a myth that agriculture returns to balance automatically. In the case of increasing supply, a disproportionately high decrease in prices can be observed and, ultimately, it turns out to be disadvantageous for revenue even in the long run.

The EU's CAP sets itself the goal of ameliorating the effects of market imperfections in areas related to agriculture. Reforms of the CAP in recent years have aimed to soften the effects of market inefficiencies in such areas as absence of remuneration to agriculture for the supply of public goods, the lower level of income compared with other sectors of the economy, and limitations on access to external financial capital (EC, 2010).

In order to model the flow of rents of price flexibility in agribusiness, it is necessary to separate processes of changes in real productivity from changes in prices of products and inputs. The change in real productivity in the agricultural sector (excluding subsidies) is calculated using the I-O (Input-Output) approach. In general, the proposed method of computing TFP change is based on indicators of total factor productivity of the Hicks–Moorsteen **(**HM TFP index, cf. Coelli *et al*. 2005), which have been decomposed in the input-output matrices for agricultural sectors of different countries. The method was developed by Lecomte and Louis (1974) and also adopted by Gburczyk (1990) as *the global productivity surplus accounts*. It is a different approach to changes in TFP than that generally found in the literature. Changes in TFP are calculated in real terms (after elimination of the effects of prices, subsidies and other payments from the CAP), not on the basis of the Malmquist Productivity Index but using input-output matrices (60 input-output variables). The Malmquist index has become extensively used in international comparisons of agricultural productivity since it does not require prices for its estimation, which are normally not available. In this case we had available a complete matrix of price indices for 60 input-output variables, prepared with the use of Eurostat data. The I-O approach to measure TFP changes has a substantial advantage: it allows to estimate monetary value of the productivity change. Then one can assess the treadmill effect and distinguish the part of the economic surplus flowing out of farms as the result of flexible prices. The change in real productivity on the farm level is expressed as follows:

$$\begin{aligned}\Delta TFP &= \left(\sum\nolimits_{i=1}^{n} Q_{it}\cdot P_{it-1} - \sum\nolimits_{i=1}^{n} Q_{it-1}\cdot P_{it-1}\right) - \\ &-\left(\sum\nolimits_{i=1}^{n} F_{jt}\cdot R_{jt-1} - \sum\nolimits_{i=1}^{n} F_{jt-1}\cdot R_{jt-1}\right)\end{aligned} \quad (1)$$

where Q_i is the quantity of product *i* in successive years (*t*–1, *t*); F_j is the quantity of external input *j* in successive years (*t*–1, *t*); P_i is the price of product *i* in year *t*–1; R_j is the price of external input *j* in successive years (*t*–1, *t*); and ΔTFP is the change in the real productivity of factors (in money units), neglecting the CAP and prices fluctuations.

In equation (1) the variable Q_i is determined by price expectations. Productivity is understood here as the output produced with given inputs. In turn, the flow of rents resulting exclusively from the change in prices of sold products and purchased means of production is given by the equation:

$$\begin{aligned}\Delta A_{st} &= \left[\sum_{i=1}^{n}\left(\frac{Q_{it}\cdot P_{it}}{HICP} - Q_{it}\cdot P_{it-1}\right)\right] - \\ &-\left[\sum_{j=1}^{m}\left(\frac{F_{jt}\cdot R_{jt}}{HICP} - F_{jt}\cdot R_{jt-1}\right)\right]\end{aligned} \quad (2)$$

where HICP is the inflation rate; ΔA_{St} is the change in the farm's economic rents in period *t* relative to *t*–1 (the drainage or inflow of economic surplus through prices known as Cochrane's treadmill effect); other symbols have the same meaning as in equation (1).

For example, a farm has additional surplus (rent) comparing to a previous period *t*–1 when the actual revenues in real prices $(\frac{Q_{it}\cdot P_{it}}{HICP})$ exceed the revenues in constant prices $(Q_{it}\cdot P_{it-1})$ deflated with producer price indices for specific outputs. Similarly, it has also unexpected surplus if the actual outlays in real prices $(\frac{F_{jt}\cdot R_{jt}}{HICP})$ is lower than the outlays in constant prices $(F_{jt}\cdot R_{it-1})$ deflated with producer price indices for specific inputs.

There are some limitations of this approach. A behaviour of farmers in our model is quite naïve since they consider a change of prices for the same amount of product (Q_{it}) in two consecutive periods. If the stationary equilibrium was reached, both the production amount and prices would change. However, in this case we assume that the equilibrium is not stationary but static. We argue that it is an effect of adaptive expectations in agriculture. The equations (1) and (2) stay in the relation: $\Delta TFP + \Delta A_S =$ *actual change in income*.

The value of pure political rents *PR* for a representative farm over a long period lasting for *n* years is computed using equation (2) in the following way:

$$\begin{aligned}&\textbf{\textit{If}}\ \boldsymbol{\Delta A_{St1} + \Delta A_{St2} + \cdots + \Delta A_{Stn} < 0}\\ &PR_{1\ldots tn} = \left(\sum\nolimits_{i=1}^{S} S_{it1} + \sum\nolimits_{i=1}^{S} S_{it2} + \cdots + \sum\nolimits_{i=1}^{S} S_{itn}\right) - \\ &-\left(\sum\nolimits_{i=1}^{g} VPG_{it1} + \sum\nolimits_{i=1}^{g} VPG_{it2} + \cdots + \sum\nolimits_{i=1}^{g} VPG_{itn}\right) + \\ &+(\Delta A_{St1} + \Delta A_{St2} + \cdots + \Delta A_{Stn})\end{aligned} \quad (3)$$

$$\begin{aligned}&\textbf{\textit{If}}\ \boldsymbol{\Delta A_{St1} + \Delta A_{St2} + \cdots + \Delta A_{Stn} \geq 0}\\ &PR_{1\ldots tn} = \left(\sum\nolimits_{i=1}^{S} S_{it1} + \sum\nolimits_{i=1}^{S} S_{it2} + \cdots + \sum\nolimits_{i=1}^{S} S_{itn}\right) - \\ &-\left(\sum\nolimits_{i=1}^{g} VPG_{it1} + \sum\nolimits_{i=1}^{g} VPG_{it2} + \cdots + \sum\nolimits_{i=1}^{g} VPG_{itn}\right)\end{aligned} \quad (4)$$

where *n* is the number of periods; $PR_{t1\ldots tn}$ is the political rent in period $t_{1\ldots tn}$; S_i is the subsidy paid to agriculture under the *s* CAP programmes; VPG_i is the payment for the public goods supplied by a representative farm according to the *g* CAP programmes (the choice of programmes is discussed below); other symbols have the same meanings as in equation (2).

By the above methodology, $PR_{t1\ldots tn}$ was computed for an average farm from the FADN representative sample of approximately 80,000 farms, according to classes based on standard output (SO) in the EU-27 Member States in the period 2004-2012. For estimating the value of rents for the whole population of representative farms using the FADN sample in a given Member State, the aggregate values $\sum_{i=1}^{S} S_{itn}$, $\sum_{i=1}^{g} VPG_{itn}$ and ΔA_{Stn} for an average farm were multiplied by the number of representative farms in the class in question[6].

CAP dilemmas of payments for public goods

The dilemmas faced by contemporary European agriculture come down to resolving the conflict between the pro-environmental and pro-social elements of the CAP, and the need to keep EU agriculture as competitive as possible. Attempts to solve these problems can be illustrated by several example areas involving instruments of the CAP. The first is the determination of the relationship between the support provided under Pillars 1 and 2. There is a conflict of interest here between farmers, who are decidedly more interested in the instruments of Pillar 1 (particularly direct, income-supporting subsidies), and consumers, who expect rural areas to function as a supplier of public goods (Cooper *et al*., 2009; Lyon, 2009), namely the preservation of landscape and natural features, biological diversity and high quality of food products. It seems that, considering the needs of a wide group of citizens, agriculture ought to fulfil the function of a quasi-public sector – that is, we can expect to observe an increase in the role played by Pillar 2. However, in order to receive specified services it is necessary to pay the farmers – otherwise they will cease such activity and engage in the production of the agricultural raw materials that become more profitable according to demand for food and prices on the world market (Czyżewski and Stępień, 2009). Observation of the evolution of rural areas in EU Member States indicates that the centre of gravity of the Polish rural economy may soon shift in the direction of increasing importance for extra-agricultural functions. This is also indicated by the CAP reforms since 2014. There is also an awareness that it is not possible for the development of rural areas to be regulated by a market mechanism. Account must be taken of preservation of the state of the natural environment and care for the rural landscape, so as to preserve the identity of the countryside in spite of the increasingly rapid changes taking place (Wilkin, 2011).

Let us return to the previously-discussed thesis that "if the resources devoted to rent-seeking even partly serve to produce public goods, then that part cannot be regarded as wastage (according to the theory of complementarity of rents and production)". It is nonetheless debatable how that part is to be defined. According to the assumptions of the concept being considered, rent-seeking farmers are also producers, and the positive external effects of their actions, having the nature of public goods, are in some sense rent-seeking outlays, in the sense of a bargaining chip providing legitimacy for the seeking of subsidies. Nonetheless, not all types of CAP subsidies carry a tangible effect in the form of public goods. The concept of a public good here is something of a generalisation. It includes not just utilities with the attributes 'non-rivalrous' and 'non-excludable' – namely pure public goods (Head, 1962; Buchanan, 1968) – but also common goods, in whose case rivalry occurs between consumers. It is debatable whether support from Pillar 1 of the CAP leads to the creation of public and common goods. A certain step in this direction is certainly provided by the cross-compliance principle, but this can be said to serve more the maintenance of the usefulness of the private resource of land and other assets for the production of high-quality food in the long term. The receipt of area payments is not subject to strong restrictions as regards the chemicalisation of agriculture or increased intensity of agricultural production, which can have a negative effect on the environment and thus on common goods. Nonetheless a number of programmes under Pillar 2 of the CAP, directed towards the development of rural areas, undoubtedly lead to the direct creation of new common goods or care for existing ones. In our view, these attributes pertain in particular to agri-environmental payments, support for least favoured areas (LFAs), set-aside payments, and to the subsidies to rural area development (RDA).

We tried to find the selection which is the least disputable, however we are aware of its limitations. If we assumed that instruments used within the CAP are strongly complementary to each other, it would be impossible to increase the provision of public goods without a growth in Pillar 1 payments. One may argue that delivering public goods is a direct by-product of agricultural activities (as in line with the multifunctionality of agriculture argument). In that sense, for having these public goods we need to have agricultural activities. The latter are supported by direct subsidies (Pillar 1 of the CAP). As a corollary to that: direct subsidies also contribute to public good deliveries (in that case our definition would be too narrow). However, by this reasoning we conclude that many more activities produce public goods, and the notion of 'public good' is too wide to support it by public funds.

We should also remember that a large part of the subsidies in the EU Member States that joined the EU prior to 2004 is of a historical nature. Thus, one can argue that introducing so-called 'payments for public goods' was used just to preserve the status quo (so that the share is held more or less constant). In other words, one may argue that changes are only the rhetoric and not the sustainable philosophy. Collating Sweden, Finland and Austria with other Member States should be treated with caution as these countries joined the EU (and the CAP) when the movement towards 'greening' was already in place. In fact, there are arguments that they used LFA or agri-environmental payments precisely to maximise their share in the budget, as with any other strategy they would be worse off. Finally, there are doubts about the efficiency of using funds for public goods. It is hard to say whether this is the optimal way to achieve the goal.

Seeking a compromise, we follow the rule that any attempt to 'green' agriculture is better than doing nothing and we assumed that the agri-environmental payments, LFAs, set-aside payments and RDA subsidies contribute to public goods provision. We analysed the contribution of the

[6] The SO classes are defined based on the value of output corresponding to the average situation in a given region for various types of agricultural production. In the FADN methodology, farms are described according to their SO values as follows: EUR 2,000-8,000: 'very small'; EUR 8,000-25,000: 'small'; EUR 25,000-50,000: 'moderately small'; EUR 50,000-100,000: 'moderately large'; EUR 100,000-500,000: 'large'; above EUR 500,000: 'very large'.

aforementioned payments (called by way of simplification 'payments for public goods') to the total subsidies paid to average farms in the EU-27 Member States in 2004-2012 (Tables 1 and 2). It was expected that, in accordance with current discussions and progressive reforms of the CAP, this share of the total subsidy would be found to be increasing. It turns out that this is one of the myths concerning the CAP. The reality is quite different, and the postulates concerning the pro-environmental and multifunctional direction of the CAP prove to a large extent to be mere declarations. In most EU Member States the level of these payments remains relatively stable, while in the others it is usually decreasing. The highest percentage of payments for public goods is recorded in Austria and Finland (ca. 40 per cent of total subsidies), countries where, in view of the unfavourable geography and consequent lower profitability of agricultural production, traditional agriculture is shrinking markedly in favour of organic production, supply of public goods and multifunctional development of rural areas. The proportion is also large, although decreasing, in Slovakia and Luxembourg (average 34 and 30 per cent respectively) and in Slovenia and Sweden (average 29 per cent). The lowest proportion accounted for by such payments is found in Denmark (4 per cent), Spain and Poland (6 per cent), and Belgium (7 per cent), where favourable conditions for production successfully compete with the realisation of extra-agricultural functions in rural areas. Also interesting are France and Germany, two of the largest agricultural producers in the EU, where in the period under analysis there was a marked fall in payments for public goods as a percentage of total subsidies – respectively from 14 to 9 per cent and from 19 to 11 per cent.

It can be assumed that the stream of subsidies theoretically linked to the supply of public goods is insufficient for them to be substituted for other payments and related productive activity. The data in Tables 1 and 2 show that payments for public goods are not more widely used in the 'old' EU-15 Member States than in the EU-12, although it appears that Romania, Bulgaria and Poland are not making full use of their possibilities in this area. In those countries the environmental potential is large, but in our view the structure of Pillars 1 and 2 of the CAP is determined by political reasons, since easily-available area payments represent the most persuasive offer to rural electorates.

Table 1: Payments for public goods as a proportion of total subsidies to an average farm in the EU-15 Member States in the period 2004-2012.

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	mean
Denmark	0.10	0.04	0.04	0.03	0.04	0.04	0.04	0.05	0.03	0.04
Spain	0.07	0.09	0.05	0.04	0.07	0.05	0.06	0.06	0.07	0.06
Belgium	0.08	0.06	0.06	0.07	0.08	0.09	0.08	0.08	0.09	0.07
Italy	0.07	0.10	0.07	0.07	0.08	0.11	0.09	0.09	0.11	0.09
France	0.14	0.15	0.09	0.09	0.08	0.09	0.08	0.09	0.09	0.10
Germany	0.19	0.13	0.12	0.10	0.10	0.09	0.10	0.11	0.11	0.11
Netherlands	0.15	0.14	0.14	0.10	0.12	0.12	0.12	0.15	0.14	0.13
Portugal	0.19	0.19	0.19	0.19	0.18	0.11	0.08	0.11	0.11	0.14
Greece	0.09	0.17	0.18	0.17	0.20	0.22	0.17	0.16	0.09	0.16
United Kingdom	0.16	0.12	0.17	0.21	0.19	0.18	0.18	0.18	0.19	0.18
Ireland	0.22	0.22	0.25	0.24	0.22	0.18	0.22	0.23	0.21	0.22
Sweden	0.32	0.29	0.27	0.31	0.24	0.25	0.30	0.30	0.32	0.29
Luxembourg	0.35	0.33	0.33	0.32	0.31	0.28	0.25	0.28	0.24	0.30
Austria	0.45	0.42	0.41	0.38	0.36	0.37	0.37	0.42	0.45	0.40
Finland	0.40	0.45	0.39	0.43	0.43	0.37	0.37	0.38	0.40	0.40

Source: own calculations based on FADN data

Table 2: Payments for public goods as a proportion of total subsidies to an average farm in the EU-12 Member States in the period 2004-2012*.

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	mean
Romania	-	-	-	0.00	0.001	0.01	0.006	0.18	0.07	0.02
Bulgaria	-	-	-	0.00	0.02	0.06	0.11	0.06	0.06	0.06
Poland	0.00	0.06	0.10	0.09	0.10	0.08	0.10	0.08	0.08	0.06
Lithuania	0.13	0.13	0.08	0.11	0.13	0.10	0.09	0.08	0.10	0.10
Cyprus	0.00	0.11	0.12	0.11	0.04	0.09	0.16	0.11	0.26	0.11
Hungary	0.00	0.13	0.12	0.14	0.17	0.14	0.20	0.24	0.22	0.11
Latvia	0.14	0.13	0.14	0.19	0.14	0.15	0.16	0.10	0.16	0.14
Malta	0.30	0.06	0.18	0.28	0.23	0.14	0.12	0.11	0.14	0.16
Czech Republic	0.20	0.21	0.23	0.21	0.25	0.22	0.20	0.20	0.20	0.21
Estonia	0.27	0.34	0.29	0.29	0.22	0.24	0.30	0.25	0.25	0.27
Slovenia	0.23	0.42	0.24	0.32	0.26	0.33	0.27	0.25	0.32	0.29
Slovakia	0.36	0.38	0.39	0.40	0.38	0.36	0.31	0.25	0.27	0.34

* 2007-2012 for Romania and Bulgaria
Source: own calculations based on FADN data

Pure political rents in EU-15 and EU-12 Member States

In accordance with the methodology adopted, political rents were computed for farms belonging to various standard output classes over a period of eight years, in the 'old' (Table 3) and 'new' EU Member States (Table 4). We recall that the values given represent that part of EU agricultural subsidies which has no objective justification either as payment for public goods or as compensation for market imperfections affecting agriculture (leading to high flexibility of agricultural prices). They therefore have the features of political rents. Our analysis is a pioneering attempt to quantify the phenomenon of pure political rent.

There are usually two arguments raised in a discussion on the differences in the per-hectare CAP payments across Member States and the total amount of subsidies resulting from these differences: (a) they exist due to the differences in historical yields, production areas, production volumes and livestock numbers; and (b) the per-hectare direct payments of the individual Member States have been converging, and this process of external convergence is to be continued. Although both arguments are reasonable, does it change anything in the interpretation of 'pure rents' distribution? As aforementioned, the pure rents in our approach has no objec-

Table 3: Political rents realised by farms by standard output (SO) class in the EU-15 Member States in the period 2004-2012.

Country	Political rents from farms by SO class (% total political rents in the country)						CAP subsidies (EUR bn)	Pure political rent (EUR bn)	Political rent (% agricultural added value)	Political rent of country (% total rents in EU-27)
	I	II	III	IV	V	VI				
France	-	-	10.3	24.6	61.2	4.0	74.72	67.26	30.6	19.3
Germany	-	-	6.4	12.4	49.5	31.7	55.95	49.29	41.6	14.1
Italy	8.7	18.9	13.2	15.6	31.5	12.1	42.18	38.39	18.2	11.0
Spain	7.0	26.1	18.2	21.0	26.2	1.5	41.99	36.12	20.1	10.3
United Kingdom	-	1.7	11.1	24.8	55.4	7.0	34.08	25.77	38.8	7.4
Greece	23.4	45.5	21.2	8.2	1.7	-	20.05	16.75	35.5	4.8
Ireland	5.5	28.6	24.6	19.5	21.8	-	15.37	11.74	95.1	3.4
Austria	-	25.3	24.7	25.9	24.0	-	15.65	9.45	45.1	2.7
Denmark	-	4.6	8.9	10.6	39.9	36.0	8.39	7.80	39.0	2.2
Finland	-	13.0	14.4	28.1	44.5	-	13.05	7.69	69.4	2.2
Netherlands	-	-	2.1	8.8	68.9	20.2	9.42	6.42	9.3	1.8
Sweden	-	8.1	13.8	16.8	48.6	12.7	7.71	5.51	46.2	1.6
Portugal	5.1	36.6	16.5	15.1	26.7	-	4.94	3.55	17.3	1.0
Belgium	-	-	5.8	45.2	49.0	0.0	10.64	2.52	13.5	0.7
Luxembourg	-	-	6.1	14.1	79.7	-	0.76	0.54	63.9	0.2
EU-15 total	9.9	20.8	13.2	19.4	41.9	13.9	354.92	288.80	38.9	82.7
EU-27 total	13.4	20.7	12.1	17.3	33.2	22.4	425.95	349.42	41.4	100.0

Source: own calculations based on FADN data

Table 4: Political rents realised by farms by standard output (SO) class in the EU-12 Member States in the period 2004-2012*.

Country	Political rents from farms by SO class (% total political rents in the country)						CAP subsidies (EUR bn)	Pure political rent (EUR bn)	Political rent (% agricultural added value)	Political rent of country (% total rents in EU-27)
	I	II	III	IV	V	VI				
Poland	15.2	31.7	19.4	12.1	12.3	9.3	24.53	22.36	36.6	6.4
Hungary	5.4	15.7	7.4	14.0	19.0	38.4	11.69	9.62	52.0	2.7
Romania	34.5	12.1	2.8	14.2	20.2	16.2	9.05	8.85	16.1	2.5
Czech Republic	-	5.5	4.1	7.7	20.7	62.0	7.85	5.79	64.8	1.7
Lithuania	24.0	29.1	14.6	11.3	13.8	7.2	3.94	3.51	58.7	1.0
Slovakia	-	-	2.4	6.4	24.4	66.8	4.59	3.05	78.3	0.9
Bulgaria	7.7	8.2	4.4	12.5	38.9	28.4	3.34	2.91	24.1	0.8
Latvia	5.4	28.8	12.0	11.6	25.8	16.4	2.19	1.80	79.1	0.5
Slovenia	13.8	31.0	17.7	25.0	12.5	-	1.99	1.38	40.1	0.4
Estonia	-	13.7	9.6	16.3	27.4	33.0	1.29	0.91	44.2	0.3
Cyprus	18.1	24.9	18.6	29.2	9.1	-	0.48	0.34	13.6	0.1
Malta	-	25.5	16.4	15.5	42.6	-	0.11	0.09	19.5	0.0
EU-12 total	15.5	20.6	10.8	14.7	22.2	30.9	71.03	60.61	43.9	17.40
EU-27 total	13.4	20.7	12.1	17.3	33.2	22.4	425.95	349.42	41.4	100.0

* 2008-2012 for Bulgaria and Romania
Source: own calculations based on FADN data

tive justification (neither as compensation for public goods, nor for the market imperfections), and thus they are simply 'a waste of resources' and 'a loss of overall well-being', no matter how relatively big they are. So, do the arguments mentioned above legitimise 'old' Member States to acquire a bigger share of pure political rents? In this sense as we propose, the pure rent has nothing to do with the yields, production, livestock number, labour efficiency etc. It has also nothing to do with the size of a country: why might larger countries have the right to waste more public funds and to reduce the social welfare of the European Community more? So, we argue that the pure rents should constitute comparable shares of CAP subsidies in each Member State since the subsidy envelopes agreed for a given programming period are a kind of political consensus. The rent-seeking level in each Member State shall be proportional to this consensus, because it would be naïve to assume that rent-seeking may disappear at all.

The pure political rents accounted for 77 per cent of the CAP subsidies on average (Figure 1). Assuming that actual CAP subsidies are a 'fair political consensus' for each country, there are Member States which profit from bigger shares of pure rents than others. More rents go to the two groups of countries:

- the biggest agricultural producers (such as France, Germany, Italy and Denmark);
- 'new' Member States with relatively big shares of agriculture in their national economies (Poland, Romania, Lithuania and Bulgaria). Considering the environmental potential of these countries, is not this a kind of free-riding?

It occurs at the expense of the countries with intensive and productive farming such as Belgium and Netherlands, as well as those with substantial environmental resources (Austria, Finland, Belgium and Slovakia). Intensive farming

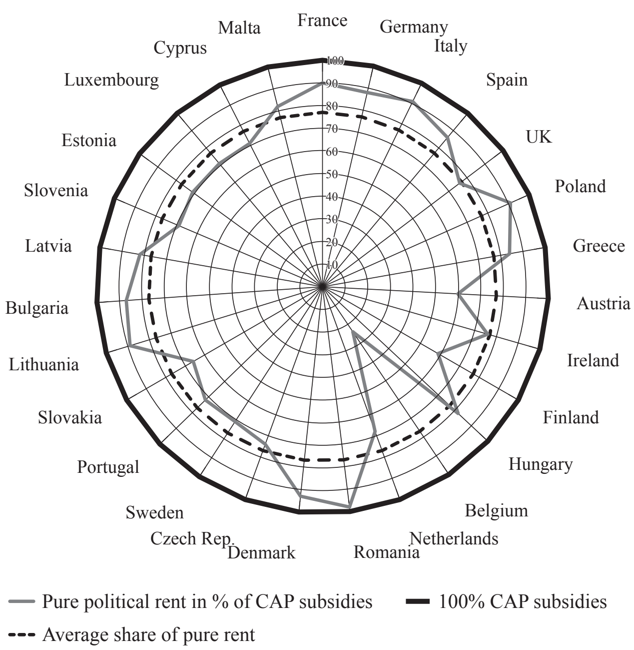

Figure 1: Pure political rents vs. consensus of the CAP EU-27 in 2004-2012.

Source: own estimation using EU FADN and Eurostat data

is likely to be more affected with market treadmill. For this reason, should some countries receive more compensation from the agricultural policy for market imperfection? Can we also reconsider if the present rent distribution is fair with regard to the countries with valuable environmental resources?

The sum of political rents in the EU in the period under analysis was estimated at close to EUR 350 billion, which is a substantial share of the EU's entire budget of EUR 860 billion for the years 2004-2013. Analysis of the rent realised per country over the analysed period as a proportion of total political rent in the EU shows that the greatest beneficiaries of rent-seeking are the Member States where agriculture is the strongest, including France (which receives almost one-fifth of the total rent), followed by Germany, Italy and Spain (with 14.1, 11.0 and 10.3 per cent respectively). Hence, farmers in just four countries capture more than one half of the political rents from the CAP. It may be thought that this is linked to the lobbying strength of agricultural organisations from those countries and their engagement in the creation of agricultural policy. Confirmation of this comes from the fact that the EU-15 Member States account for 83 per cent of the total political rents in the EU-27.

Analysis at individual Member State level indicates that it is possible to distinguish those where the value of total realised rent is:

- relatively equal among farms in different standard output classes (e.g. Austria);
- highest among large and very large farms (e.g. the Czech Republic, Slovakia, Hungary, Germany, Denmark, Finland, the Netherlands and Luxembourg);
- highest among small and very small farms (e.g. Greece, Lithuania and Romania).

Such a distribution may be a result of the differentiated structures of farms in different Member States, and consequent differences in the political importance of the rural electorate associated with particular SO classes. For example, in Poland approximately one third of political rents are received by SO class II (small farms), and these together with class I (very small farms) account for almost one half of total rents. These classes represent more than 90 per cent of the rural electorate, and as can be seen, Olson's theory of interest groups, according to which a stronger political influence is exerted by small but well-organised groups, does not apply here. Similar situations exist in Romania, Lithuania and Latvia, where the agrarian structure is again very fragmented, but also in Portugal, Greece, Cyprus and Slovenia. A cautious conclusion can therefore be drawn, that the distribution of political rents corresponds to the structure of farms in a given country, such that the most numerous groups receive the largest pool of political rents. Hence no confirmation is found for the popular opinion that the largest political rents are obtained by sector of the strongest farms. On the other hand, economic size categories based on SO should be used with caution in this type of analysis because the physical size of farms corresponding to a certain SO class varies widely between Member States due to the differences in market prices, yields and produce quality. Bearing in mind the heterogeneity of farms within each SO class, we however believe that the comparison of the relatively smallest farms (I SO in 'new' Member States or III SO in 'old' Member States) with the highest SO class in the respective country is quite reasonable and gives a general overview for the rent-seeking problem.

A category of note is that of very large farms (SO class VI) in Belgium, where there was no political rent at all in the analysed period, which means that the sum of the subsidies received by a farm, adjusted by payments for the supply of public goods, is not able to compensate for the surplus drainage caused by price flexibility.

Another issue is the contribution of political rents to the added value from agriculture in a given country, shown in the penultimate column of Tables 3 and 4. On average, in the EU-27 this contribution is 41.4 per cent, and although in the EU-12 it is slightly higher, and in the EU-15 somewhat lower than average, there are Member States in which that value is exceeded almost twofold. We analysed the reason why political rents account for more than 95 per cent of the added value of agriculture in Ireland, and 78 per cent in Slovakia. In all of the extreme cases the problem lies in the low real productivity of agriculture, and not in market imperfections, which affect agriculture in all Member States to a similar degree apart from those with the most intensive farming. Irish agriculture uses a very large quantity of materials – the ratio of indirect consumption to production averages approximately 1 over the year, compared with an EU average of 0.66. A similar conclusion applies to agriculture in Slovakia and Latvia. In the Czech Republic, the cause is rather the relatively high cost of labour.

It can be asked whether such extreme differences in the level of subsidisation of low productivity from the CAP budget is socially just, in terms of the balance of costs and benefits for the community as a whole. What benefits do the EU taxpayer obtain by subsidising highly inefficient agriculture in certain Member States? Naturally, indirect benefits can be found, such as the maintenance of agricultural incomes and thereby the livelihood of rural areas, prevention of depopulation of those areas, and assurance of internal demand for food. This may be an indication of how the CAP could be more effectively modified so as to achieve the desired effects, at least those relating to the supply of public goods. Perhaps countries with structurally inefficient agriculture ought to supply more public goods than they do at present, or else subsidise their agriculture to a greater degree from national funds.

Conclusions

The analysis carried out here leads us to conclude that agricultural interventionism in the EU requires a special conceptual approach, since it is not sufficient simply to treat all subsidies as political rents. The new approach we propose provides an indication of how to improve the effectiveness of allocation of support for agriculture in individual EU Member States. A principal finding of this study is that, when using the concept of pure political rent, the EU CAP consensus (Figure 1) seems to be much more debatable than is usually believed since some Member States gain unexpected and unjustified advantages. Moreover, we pointed out that it is confusing to call all CAP subsides 'the political rents' in terms of the rent-seeking theory. Quantification of the political rent in agriculture enables a more rational and socially-appropriate distribution of support from the CAP in accordance with the agricultural policy goals in the financial framework after 2014. Measuring pure political rents has revealed a new dimension of inequalities in the distribution of CAP subsidies which particularly badly affect the most productive and the most eco-efficient Member States. Although the division of payment envelopes between Member States has been decided, since 2014 the CAP has gained flexibility in terms of the structure of both Pillars and transfers between them. These matters remain in the hands of the Member State governments. The problem may be that in many countries the breaking of the link between subsidies and output was reflected more in declarations than in facts, and ways are constantly being sought to 'get round' that requirement. Such attempts exacerbate King's effect, and mean that a large share of the subsidies is not capitalised within agriculture, but are captured by surrounding sectors. Economic surplus flowed out of farms in the period 2004-2012 through the unfavourable changes of prices, particularly of fertilisers, energy and feedstuffs, but also milk and poultry livestock (Czyżewski and Matuszczak, 2017; Czyżewski, 2017) We have in mind here the fact that, for example, investment support goes mainly to the largest farms, where it is subject to the strongest drainage through price flexibility.

Redefinition is also required about the issue of social fairness in the determination of the sizes of national CAP envelopes. The calculations of political rents show that historical payments are neither a rational nor a just solution, because the structurally low profitability of agriculture in certain Member States ought to be compensated for by a higher supply of public goods, and this is not happening. On the other hand, the most productive food suppliers and public goods providers are not proportionally 'rewarded' with political rents. Of course, we are being somewhat facetious and we do not claim that the pure political rent is a reward for a productivity or eco-efficiency. But in fact, the present CAP consensus seems to be the least favourable for the Member States that are leaders in productivity and eco-efficiency.

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SZERLETICS Ákos*

Degressivity, capping and European farm structure: New evidence from Hungary

The debate on reforming the Common Agricultural Policy (CAP) after 2020 had already started when the European Commission published its own vision on the future of agriculture and food production in the European Union. One of the key aspects of this debate relates to the revision of the system of EU direct payments by revising degressivity and capping rules. Although it has, for a long time, been a popular idea to limit payments to larger farms in one way or another, and subsidise smaller agricultural holdings instead, this idea has serious drawbacks as this paper shows. The aim of this study is to analyse the impact of degressivity and capping on European farm structures by reviewing existing literature on the topic as well as by providing new evidence from Hungary. Results suggest that placing a cap on direct payments may be causing more harm than good in terms of land use change.

Keywords: degressivity, capping, CAP, Hungary

JEL classification: Q18

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Introduction

In 2013, a general agreement was made by the European Council and the European Parliament on the reform of the Common Agricultural Policy (CAP) for the period 2014-2020. The agreement was the result of many years of negotiations on different issues and topics. One of the most heavily debated issues was degressivity and capping, aimed at providing a more equitable distribution of direct payments by farm.

On the one hand, the possibility of reducing/limiting direct payments for large farms has always been a popular idea amongst liberal agricultural economists and decision makers throughout the history of the CAP. The need for 'balancing' direct payments was even expressed in the MacSharry reform proposals in 1992 when direct payments were introduced. On the other hand, degressivity/capping was heavily opposed by countries where large farms dominated the agricultural sector.

It seems that the opponents have won as original ideas on degressivity/capping have largely been watered down after the 2013 removal of modulation (Sahrbacher *et al.,* 2015). The aim of this paper is to analyse the impact of degressivity and capping on European farm structures by reviewing the existing literature on the topic as well as by providing new evidence from Hungary.

The paper is structured as follows. The second section provides a review of the existing literature on the impact of the Common Agricultural Policy (CAP) on European farm structures, followed by a political economy analysis of degressivity and capping. The fourth section shows the uneven distribution of direct payments in Europe, followed by the presentation of the Hungarian evidence. The last section concludes.

The impact of CAP on European farm structures

A large amount of literature is dedicated to the investigation of the impact of CAP measures on structural changes of agricultural holdings. According to EC (2015), there were 11 million farms cultivating 172 million hectares of agricultural land with 22 million people in European agriculture in 2015. EC (2013) suggests that the number of farms has been declining since 1975 and those remaining have become bigger both in terms of agricultural area and also in economic terms. On the whole, the majority of European farms are small, both physically and economically, but the average farm size is increasing.

Generally studies conclude that the CAP has a high impact on farm structures in Europe (Table 1). Breustadt and Glauben (2007) investigated the driving forces behind exiting from farming in Western Europe based on 1993-1997 data to 110 regions in EU-12 by simulating the simple theoretical model of structural change. Their results show that exit rates are lower in regions with more part-time farming, high subsidy payments and high relative price increases for agricultural outputs. The authors suggest that opportunities to combine farm and off-farm income as well as government intervention slows down structural change in European agriculture. These results, however, should be handled with caution as CAP was significantly different in the 1990s to the way it is implemented today.

Bartolini and Viaggi (2013) analysed the determinants of changes in EU farm size based on data obtained from a 2009 survey of over 2363 farm households in 11 Catudy Areas (CSAs) in 9 different European Countries. By also applying simulation modelling, the authors found that single payment scheme models affect the changes in demand for land and CAP abolition strongly reduces the intention to increase the amount of farmed area. Geographic variables, farm characteristics and the number of on-farm employees are found to be factors relevant to explaining planned farmed area expansion.

Happe *et al.,* (2009) investigated the role of CAP in shaping Slovakian farm structure by agent-based modelling as well for 2002 as a base year, based on data of 327 farms. Their results suggest that that direct payments had a strong impact on the structural development of Slovakian farms in the long run and have made farm structure increasingly homogenous towards larger farm sizes. Moreover, the SPS system was found to persuade single farm holders, otherwise hesitating to exit from the sector, to stay in agriculture

Some studies focus on the role of generation renewal in agriculture as a prerequisite for structural change in the sector. As fewer and bigger farms are offering fewer jobs in Europe, agricultural employment possibilities for young farmers are also shrinking. Young farmers (classified as younger than 35 years) made up 6% of all farm holders in Europe, while elderly farmers (above 55 years) account for 55% of farms in 2007. Moreover, statistics suggest that elderly farmers are generally not retiring and passing on their farms to the younger generation, thereby creating serious consequences on the overall growth potential of the sector. What is more, there are fewer young people in the agricultural sector than in any other sector of the economy (EC, 2011a).

Davis *et al.,* (2013) investigated the efficacy of incentives for new entrants to farming as an alternative to early retirement schemes for farmers in Northern Ireland by employing a dynamic farm optimisation model for survey data with 2001 as a basis year. The authors found new entrant schemes having a positive impact on entry of young farmers, especially in the case of interest rate subsidies on farm development loans.

A comprehensive review on the main challenges young farmers are facing with as well as the evaluation of the efficiency of young farmer schemes can be found in Regidor (2012) as well as in Zagata and Sutherland (2015). Their results, based on simple descriptive statistics, suggest that young farmer schemes have very limited effects on encouraging new entrants to agriculture.

Other studies focus on the impact of CAP on farm exit in terms of structural change and studies generally argue that CAP plays a crucial role in retaining farmers in the sector. On the one hand, farm exit strategies under CAP elimination scenarios were analysed by Raggi *et al.,* (2013), building on survey data carried out in 9 EU countries in 2009, ending up in a sample of 2300 farms-households. By using a probit Heckman model, results suggest that numbers of farm households opting to exit from agriculture increased sharply under the scenario characterised by the removal of the CAP. Their article holds the clear policy message that the current CAP payments are important for staying in/exiting farming activities, but the land reallocation process (as a consequence of land abandonment) clearly requires more targeted instruments (towards young and active farmers, in order to avoid fragmentation, dispersion, or attraction only for speculation purposes).

Olper *et al.,* (2014) examined the different instruments of the CAP on the out-farm migration in a sample of 150 EU regions of the EU-15 over the period 1990-2009 by using fixed effects and GMM regressions. Results suggest that CAP payments generally contribute to keeping labour in agriculture and especially coupled subsidies seem to be the most effective in reducing out-farm migration through obligatory production (and hence labour input).

Peerlings *et al,* (2014) investigated the resilience of European farms with and without the CAP and applied binomial and logit regression models on survey data on 11 case study regions in 9 EU countries conducted in 2009. Results show that farms choosing to exit are those most dependent on CAP support, lease a relatively large share of their

Table 1: Summary of studies on the impact of the CAP on the structure of agricultural holdings.

Study	Method	Unit of analysis	Time	Type	Result
Breustadt and Glauben (2007)	Simulation model	EU-12	1993-1997	Ex-post	Government intervention slows down structural change in European agriculture
Bartolini and Viaggi (2013)	Simulation modelling	EU-27	2009	Ex-ante	Single payment scheme models affect the changes in demand of land and CAP abolishment strongly reduces the intention to increase the amount of farmed area
Happe *et al.* (2009)	Agent-based simulation modelling	Slovakia	2002	Ex-ante	Direct payments make farm structure increasingly homogenous towards larger farm sizes
Davis *et al.* (2013)	Dynamic farm optimisation model	Northern Ireland	2001	Ex-ante	New entrant schemes having a positive impact on young farmers, especially regarding interest rate subsidies on farm development loans
Raggi *et al.* (2013)	Heckman probit model	EU-27	2009	Ex-ante	CAP payments are important for staying in/exiting farming activities, but the land reallocation to young farmers process clearly requires more targeted instruments
Olper *et al.* (2014)	Fixed effects and GMM regression	EU-15	1990-2009	Ex-post	CAP payments generally contribute to keeping labour in agriculture and especially coupled subsidies seem to be the most effective in reducing out-farm migration
Peerlings *et al.* (2014)	Binomial and logit regression models	EU-27	2009	Ex-ante	Least resilient and most CAP-dependent farms are most likely choosing to exit agriculture
Petrick and Zier (2011)	Difference-in-differences panel data regression	Germany	1999-2006	Ex-post	Pillar I and II payments generally ended up in exit of labour from agriculture via investment and capital/ labour substitution effects
Tocco *et al.* (2013)	Bivariate probit models	France, Hungary, Italy, Poland	2005-2008	Ex-post	Decoupled payments kept labour in agriculture in the NMS but not in the OMS

Source: own composition

land, and are part-time and diversified farms. These farms were confronted with a relatively high drop in income in the event of CAP abolition and faced relatively high adaptation costs when adjusting their factor input use or simply did not have sufficient assets to be able to survive as farms in a no-CAP world. The results also indicate that – besides being less likely to exit – more specialised farms with young farm heads are most resilient, and small, more diversified farms headed by old farmers are least resilient.

On the other hand, Petrick and Zier (2011) analysed regional employment impacts of the CAP measures in Eastern Germany based on regional data of 1999-2006, resulting in 483 observations. By using a difference-in-differences regression model, the authors found that investment aids and transfers to less-favoured areas had a zero marginal employment effect. They also present evidence that full decoupling of direct payments led to labour shedding, as it made transfer payments independent of factor allocation. Spending on modern technologies in processing and marketing and measures aimed at the development of rural areas led to job losses in agriculture. However, agri-environmental measures, kept labour-intensive technologies in production or induced them.

Tocco *et al.,* (2013) examined the determinants of exit from agriculture of CAP payments in France, Hungary, Italy and Poland in 2005-2008 by bivariate probit models and found that total subsidies were negatively associated with the out-farm migration of agricultural workers in Hungary and Poland, implying that the CAP hindered labour exit from agriculture. Conversely, results were exactly the opposite for France and Italy, representing 'Old Member States'. When analysing impacts of policy changes, the authors conclude that the OMS reacted more to the decoupling in the period analysed while the NMS responded to the recent introduction of EU subsidies.

The political economy of degressivity and capping

The uneven distribution of direct payments has been on the Europe policy agenda for 25 years (direct payments were introduced by the MacSharry reform in 1992). Attempts to limit payments made to large farms have systematically been brought up in all CAP reforms so far (Sahrbacher *et al.,* 2015). As 80% of payments are received by 20% of farms in Europe, the idea seems reasonable and has gained wide public support.

However, it was only in 2005 when a 5% compulsory reduction of direct payments of farms receiving more than €5,000 (modulation) was first implemented, transferring funds from the first pillar of the CAP to the second. From 2009 as a part of a political compromise, modulation rates were stepwise increased to 10% until 2012 and set 4% higher for large farms (progressive modulation) in the belief that the issue has completely been solved (Anania-D'Andrea, 2015).

In the Commission's original proposal published in October 2011 (European Commission 2011a), direct payments were proposed to be reduced by 20% for the tranche of more than €150,000 and up to €200,000; by 40% for the tranche of more than €200,000 and up to €250,000; by 70% for the tranche of more than €250,000 and up to €300,000 and by 100% for the tranche of more than €300,000. However, the Commission allowed these amounts to be 'calculated by subtracting the salaries effectively paid and declared by the farmer in the previous year, including taxes and social contributions related to employment, from the total amount of direct payments initially due to the farmer without taking into account the payments to be granted pursuant to Chapter 2 of Title III of this Regulation' (EC, 2011a, p 28.). The text also added that 'Member States shall ensure that no payment is made to farmers for whom it is established that, as from the date of publication of the Commission proposal for this Regulation, they artificially created the conditions to avoid the effects of this Article' (EC, 2011a, p 29.).

There has been a heavy debate on the original proposal above. Germany, Great Britain, Italy, Romania, Czech Republic, Slovakia, Sweden and the Netherlands rejected any capping on direct payments by arguing that capping would discriminate between farms according to their size, contradicting the original principles of the CAP Sahrbacher *et al.,* (2015). These countries also argued that capping would result in artificial split of large farms (see next section for evidence).

However, at the other end, Bulgaria, Austria and Poland were in favour of capping, mainly because of their extremely concentrated farm structures as well as their relatively disadvantaged positions in terms of direct payments per hectare. Another argument against capping was that several New Member States inherited dual farm structures from the socialist era, dominated by large-scale units. However, as salaries and wage levels were relatively low in this part of Europe, these countries would have been the most affected in degressivity and capping (Sahrbacher *et al.,* 2015).

All in all, the final decision introduced a mandatory reduction of 5% for the part of basic payments exceeding €150,000. Member states, however, are allowed to increase the degressivity rate up to 100%, making de facto the €150,000 threshold a 'cap' on basic payments. Member states were also allowed by the Ciolos-reform to apply the reduction after deducting labour costs of the previous year from the basic payment. Such 'savings' resulting from degressivity were then to be added to the EAFRD 'envelope', free of any co-financing by the member state. Note that member states were exempted from mandatory degressivity if voluntary redistributive payments were implemented, absorbing more than 5% of its ceiling for direct payments (Anania-D'Andrea, 2013).

In practice, fifteen member states where degressivity was implemented decided to apply the minimum possible percentage cut (without imposing any cap), while nine member states decided to put a cap on direct payments (Table 2). The EC estimated that for the period 2015-19, degressivity and capping would result in a 'saving' of €112 million, which is less than 0.3% of the financial resources allocated to direct payments in the EU-28 (Anania and D'Andrea, 2015). Such a low rate of 'savings', however, was not a surprise after the Commission's initial impact assessment (EC, 2011b), which talked about a 1.3% release of the total amount of direct payments at the EU level, equivalent to around €590 million. Sahrbacher *et al.,* (2015) highlight that this was much less

Table 2: Degressivity and capping applied by the EU Member States.

Country	Degressivity	Capping
Austria	YES	Cap at 150,000€
Belgium (Flanders)	YES	Cap at 150,000€
Bulgaria	YES, cut of 5% above 150,000€	Cap at 300,000€
Cyprus	YES, cut of 5% above 150,000€	NO
Czech Republic	YES, cut of 5% above 150,000€	NO
Denmark	YES, cut of 5% above 150,000€	NO
Estonia	YES, cut of 5% above 150,000€	NO
Finland	YES, cut of 5% above 150,000€	NO
Greece	NO	Cap at 150,000€
Hungary	YES, cut of 5% above 150,000€	Cap at 176,000€
Ireland	NO	Cap at 150,000€
Italy	YES, cut of 50% above 150,000€	Cap at 500,000€
Latvia	YES, cut of 5% above 150,000€	NO
Luxembourg	YES, cut of 5% above 150,000€	NO
Malta	YES, cut of 5% above 150,000€	NO
Netherlands	YES, cut of 5% above 150,000€	NO
Poland	NO	Cap at 150,000€
Portugal	YES, cut of 5% above 150,000€	NO
Slovakia	YES, cut of 5% above 150,000€	NO
Slovenia	YES, cut of 5% above 150,000€	NO
Spain	YES, cut of 5% above 150,000€	NO
Sweden	YES, cut of 5% above 150,000€	NO
United Kingdom (England)	YES, cut of 5% above 150,000€	NO
United Kingdom (Northern Ireland)	NO	Cap at 150,000€
United Kingdom (Wales)	YES, cut of 15% above 150,000€, progressively increasing up to 300,000€,	Cap at 300,000€
United Kingdom (Scotland)	YES, cut of 5% above 150,000€	Cap at 500,000€

Note: The table just contains countries applying degressivity/capping
Source: own composition based on Anania and D'Andrea (2015)

than the amounts coming from modulation (around 3 billion in 2013), while Matthews (2016) shows that by introducing degressivity and capping, Member States reduced their EU direct payment envelopes, as laid down in Annex II of Regulation (EU) No 1307/2013 of the European Parliament and of the Council, by around €109 million, in 2015. Almost two-thirds of this reduction was committed by Hungary.

As to the latest reform ideas, In its Communication "The Future of Food and Farming" of 29 November 2017 (European Commission, 2017), the European Commission proclaims capping as compulsory, and would allow for Member States to introduce or maintain the degressive reduction of direct payments. As for the capping of direct payments, costs of labour could be considered to avoid negative effects on jobs. Member States would be also encouraged to redistribute direct payments to better target small agricultural holdings. These would be the tools of the post-2020 CAP which could influence the distribution of direct payments among the beneficiaries.

The uneven distribution of direct payments in Europe

On average, 80% of the beneficiaries (88% for Bulgaria and Romania) received around 20% of direct payments in 2015 with important differences among member states (EC, 2015). A detailed analysis of the respective dataset provides further information on the payments related to degressivity/capping (Table 3).

German farms received above €150 thousand, the highest amount in the EU-28 in 2015, while the highest share of direct payments under degressivity was found in Slovakia (71% of payments were made above this threshold). The highest number of beneficiaries receiving direct payments above €150 thousand could also be found in Germany (Table 3). The highest share in this regard is observable for Czech Republic (5.17%). Moreover, the average payment above €150 thousand to recipients was the highest in Croatia (almost €500,000 per beneficiary).

The idea of degressivity/capping described above, however, is not theoretically perfect. Bureau and Mahé (2015), for instance, found capping of payments almost completely ineffective at the European level. By allowing member states to choose different degressivity/capping options, the equal distribution of direct payments remains only rhetoric. The authors find a 'general reluctance' of member states to introduce effective capping. They also argued that deducing labour costs is a strange way of fostering rural employment as wage rates were mainly set by the national labour market, thereby resulting in a biased transfer of land and capital to labour. Moreover, heterogeneous proportions of large farms across Europe also make the capping idea hard to implement.

Table 3: Direct payments paid above €150,000 by member state, 2015.

Country	Amount paid (in 000 €)	Out of total (%)	Number of beneficiaries	Out of total (%)	Average payment to recipients (in €)
Austria	11,213	1.59	41	0.01	273,488
Belgium	11,440	2.08	58	0.17	197,241
Bulgaria	203,577	31.62	709	0.72	287,133
Croatia	25,747	16.16	52	0.01	495,134
Cyprus	695	1.35	4	0.01	173,750
Czech Republic	583,062	66.07	1,543	5.17	377,876
Denmark	164,160	17.42	747	2.53	219,759
Estonia	20,393	18.42	87	0.51	234,402
Finland	5,570	1.06	29	0.01	192,069
France	254,786	3.35	883	0.24	288,546
Germany	1,130,648	21.99	3,545	1.12	318,942
Greece	1,727	0.08	10	0.01	172,700
Hungary	432,039	33.63	1,090	0.01	396,366
Ireland	12,263	11.08	64	0.01	191,609
Italy	426,730	10.86	1,588	0.14	268,722
Latvia	13,153	8.40	59	0.01	222,932
Lithuania	38,116	9.67	144	0.10	264,694
Luxembourg	407	1.23	2	0.01	203,500
Malta	n.a.	n.a.	n.a.	n.a.	n.a.
Netherlands	46,548	5.82	209	0.44	222,287
Poland	222,663	6.64	728	0.01	305,856
Portugal	76,957	11.93	335	0.21	229,722
Romania	233,581	16.46	785	0.01	297,555
Slovakia	305,630	70.87	816	4.62	374,547
Slovenia	7,554	5.56	16	0.01	472,125
Spain	417,361	0.08	1,569	0.01	266,004
Sweden	44,898	6.53	205	0.33	219,015
United Kingdom	431,485	13.87	1,714	1.03	251,742
EU-28	5,122,413	12.14	17,032	0.24	300,752

Source: own calculations based on DG AGRI (2015)

New evidence from Hungary[1]

According to the latest national statistics (HCSO, 2017), there were 9 thousand agricultural enterprises and 416 thousand agricultural holdings engaged in agriculture in 2016. However, many of the latter were subsistence or semi-subsistance farmers cultivating agricultural areas less than one hectare. According to the Hungarian Paying Agency, however, there were only 173,578 farms applying for direct payments in 2016, accounting for 41% of total farms.

The distribution of direct payments in Hungary is well in line with European evidence (Figure 1). Almost 50% of beneficiaries received less than 5% of the total payments, while 34% of payments were received by 1% of the beneficiaries. Most beneficiaries receive direct payments between €500 and €1250 (small farmers), while the highest amount of payments pertain to the €20-50 thousand size category.

In terms of degressivity/capping, Hungary chose to apply a 5% cut above €150,000 and a cap at €176,000, as evident from Table 1. Degressivity was applied to 568 farms in 2015 (out of which capping was applied to 74) and to 534 farms in 2016 (out of which capping was applied to 60). The average amount deduced was €144,531 in 2015 and €153,022 in 2016. The total amount 'saved' by degressivity was €46,371,476 in 2015 €39,331,252 in 2016 (compared to €69,746,000 in 2015 and €68,961,000 in 2016 moved from the first pillar to the second).

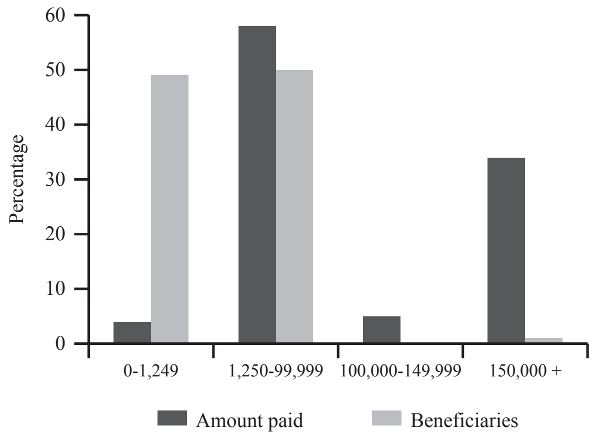

Figure 1: Distribution of direct payments and beneficiaries in Hungary, by amount received (thousand euro), 2015 financial year.
Source: own composition based on DG AGRI (2015) data

[1] All data in this section are from the Hungarian Paying Agency.

Table 4: Number of farms by physical size categories in Hungary, 2012-2016.

Farm size (UAA)	2012	2013	2014	2015	2016
0-3 ha	58,546	59,732	60,143	55,373	54,922
3.01-5.00 ha	25,448	25,653	25,280	25,698	25,456
5.01-10.00 ha	32,214	32,433	32,134	33,808	33,863
10.01-25.00 ha	30,465	30,280	30,195	28,961	28,572
25.01-50.00 ha	12,997	13,032	13,024	13,035	13,044
50.01-100.00 ha	7,689	7,761	7,792	8,170	8,308
100.01-300.00 ha	6,509	6,574	6,669	6,979	7,154
300.01-600.00 ha	981	982	1,067	1,231	1,227
600.01-1,200.00 ha	556	566	565	701	773
1,200.01 ha -	477	443	439	323	259
Total	175,882	177,456	177,308	174,279	173,578

Source: own composition based on Hungarian Paying Agency data

As a new result, the number of farms by physical size categories before and after degressivity/capping was implemented is analysed here. Results echo the fear of Bureau and Mahé (2015), suggesting that degressivity/capping leads to the splitting up of farms. As it is observable from Table 4, the number of farms with over 1200 hectares UAA (affected by capping) decreased by 26% and by 41% from 2014 to 2015 and 2016, respectively. In contrast to this decline, the number of farms with 600-1200 hectares UAA increased by 36% from 2014 to 2016, while the number of farms with 300-600 hectares UAA also grew by 15%.

However, note that changes above are also due to the new Land Transaction Act in force since 2014. According to this, only active farmers (and their family members) living in Hungary and obtaining at least a secondary agricultural and/or forestry qualification can buy land up to 300 hectares in total. National and foreign legal entities are excluded from the Hungarian land market. Moreover, the total area of land used by farmers cannot exceed 1,200 hectares (except for livestock farms and seed producers where the limit is 1,800 hectares). Furthermore, in the new Land Transaction Act, pre-emption rights are provided for the Hungarian State, the farmer using the land, the neighbouring farmers, local farmers and farmers living within a 20 km distance.

All the above creates high administrative burdens and strong state control for local land markets. In terms of land use regulations, Hungarian land policy favours family farms instead of large farms, in line with its capping ceilings (note that €176,000 euro corresponds to 1200 ha in Hungary). On the whole, land regulations together with degressivity/capping are both responsible for the splitting up of large farms.

Conclusions

The paper has analysed the impact of degressivity and capping on European farm structures by reviewing the literature and showing new evidence from Hungary. Results suggests that the CAP has had a high impact on farm structures. The vast majority of the studies conclude that government intervention slows down structural change in European agriculture, though the overall impact of different policy measures is rather mixed. Subsidies keep labour and farms in agriculture, and therefore also act against structural change necessary for productivity purposes. This somehow echoes the original dilemma – whether the CAP wants European agriculture to become productive (competitive) or socially fair (inclusive).

The answer seems to be both as the political economy analysis of degressivity and capping suggests. The aim of direct payments is at least as much to increase competitiveness of farms as to be socially fair and equal by redistributing payments by farm size. However, as is evident from the above data, capping seems to be causing more harm than good. As the Hungarian example shows, it has actually decreased farm sizes and contributed to massive farm splitting. Therefore, the question today pertains not to the exact rate of degressivity and capping but rather to its very existence as the continuation of this idea seems to lead to the creation of smaller and hence less competitive farms. The idea of capping has, in practice, had results the opposite of what was intended.

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Effectiveness of Greening in Poland

Under the latest reform of the Common Agricultural Policy, 2015 was the first year when greening requirements were implemented. Legal rules obliged farmers to move towards more environmentally-friendly land use practices. The aim of this paper is to present the first effects of the implementation of greening in Poland. The paper is based on an FADN panel of 7.4 thousand private farms participated in the Single Area Payment Scheme in Poland. The sample also enabled to identify organisational changes in agricultural production after greening. Results suggest that Polish farms have adapted well to greening requirements and the new system has not caused productivity and profitability of Polish farms to decrease in 2015.

Keywords: Greening, Common Agricultural Policy, Effectiveness, FADN farms, Poland

JEL classification: Q18

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Introduction

The European Union has as an aim the sustainable development of agriculture and rural areas, an objective which is reflected in design of the Common Agricultural Policy (CAP) instruments (Kociszewski, 2014; Krzyżanowski, 2015). The CAP has come under increasing criticism for not doing enough to limit the negative effect that certain farming practices have on the environment and climate, the acknowledgement of which recently justified setting a new direction for agriculture development and support (European Court of Auditors, 2017a:10).

Under the new direct payment scheme, an obligation has been introduced since 2015 to apply agricultural practices deemed favourable for the climate and the environment, the so-called greening requirements. Greening is a major innovation brought in under the 2013 CAP reform, making the system of direct payments more environmentally friendly. Mandatory green standards connected to direct payments of the first pillar of the CAP were defined as a novel approach (Matthews, 2013). "It was designed to reward farmers for having a positive impact on the environment which would otherwise not be rewarded by the market" (European Court of Auditors, 2017b: 1). The introduction of the new greening measures within Pillar 1 of the CAP was a significant but controversial aspect of this reform (Hart *et al.,* 2016:57).

All farmers entitled to the Single Area Payment Scheme in 2015 are obliged to implement greening, the extent depending on agricultural surface and structure. Currently, 30% of the national financial envelope is connected with greening. In 2015, the rate of greening payment in Poland amounted to about 70 EUR/ha (MRiRW, 2015).

Depending on the area of arable land used and the share of permanent grassland, farmers are required to follow one, two or three greening practices. Greening practices include: diversification of crops (applicable to farms with an arable land area of 10 ha or more), (b) maintenance of permanent grassland[1] (the ratio of grassland to total agricultural area may not decrease by more than 5% compared to the reference ratio) (MRiRW, 2015), (c) maintenance of Ecological Focus Areas (EFA) on at least 5% of arable land (this applies to farms with an arable land area of 15 ha or more).

The greening mechanism involves many equivalent pro-environmental practices, the selection of which is left to the individual farmer (Hart, 2015). Such a mechanism has allowed farmers to choose practices that are relevant to the specific character of their farms, including their location and the landscape (including valuable landscape elements within the farm), and the mode of agricultural production.

The requirement of crop diversification binds farmers to grow at least 2-3 different crops on arable land (depending on its area) and defines their percentage in the cropping pattern. Crops may also be diversified by using an equivalent practice applied as part of the agri-environment and climate measure under the RDP 2014-2020 (MRiRW, 2017b). As regards the EFA maintenance requirement, its fulfilment entails the maintenance of landscape, forest and agricultural features. Agricultural features include fallow land and the cultivation of plants that favourably affect soil condition, including the cultivation of nitrogen-fixing plants in the main crop, also in the form of catch crops and companion crops[2].

EU regulations also provide for a number of exemptions from the greening obligation. Farms where over 75% of agricultural land is permanent grassland or farms with a high percentage (over 75%) of arable land used for production of grass or other green fodder crops or fallowed due to the favourable environmental impact are exempted from the crop diversification obligation or the obligation to maintain ecological focus areas[3]. Farms that participate in the small farms scheme are allowed to receive the greening payment despite the exemption from the greening obligation. The greening payments are automatically granted to farmers who

[1] The reference ratio is calculated as a ratio of the permanent grassland area (declared in 2012 and new permanent grassland area, not included in 2012 but declared in 2015) to the total agricultural land declared in 2015 (ARiMR, 2015b). As indicated in the announcement of the Minister of Agriculture and Rural Development (Dz. U. of 30/11/2015, item 1163), the reference ratio was 18.75%.

[2] The selection of specific EFA-eligible elements is to be made by individual Member States (EC, 2017d).
EFA elements in Poland: EFA1. fallow land, EFA2. hedges, EFA3. single trees, EFA4. trees in line, EFA5. trees in group, EFA6. field margins, EFA7. ponds, EFA8. ditches, EFA9. buffer strips, EFA10. land strips without production along forest, EFA11. land strips qualified for the payment, located along forest edges, EFA12. short-rotation coppice, EFA13. afforested areas, EFA14a. stubble catch crops, EFA14b. winter catch crops, EFA 14c. undersown grasses, EFA15. nitrogen-fixing crops, see: (ARiMR, 2015a).

[3] Provided that the arable land area does not exceed 30 ha.

operate their farms in line with organic farming principles (ARiMR, 2015a; DPB, 2016; MRiRW, 2015).

In general, greening requirements have allowed farmers to get total support within the framework of direct payments. Farmers who use farmland in more sustainable way and care for natural resources benefit financially. As the European Commission (EC) justifies "Greening supports action to adopt and maintain farming practices that help meet environment and climate goals. Market prices do not reflect the effort involved in providing these public goods" (EC, 2017b). Changing agri-environmental practices as a condition of obtaining additional support helped spread the "provider gets principle" (Mauerhofer *et al.,* 2013). According to the instrument's underlying assumption, the majority of farmers were entitled to green payments, a fact which guaranteed the popularisation of those practices on the majority of EU agricultural land.

The aim of this paper is to present the first effects of greening implementation in FADN farms in Poland, in the context of requirements concerning crop production organisation and the maintenance of ecological focus area (EFA). The paper presents the organisation and outcomes of farms before and after greening introduction, both those entities that were obliged to comply, and those that were exempted from new requirements. The popularisation of greening practices indicates the efficiency of agricultural policy implementation.

The paper is structured as follows. The first section after introduction gives an overview of the existing literature on the topic, followed by the presentation of the research methodology. The fourth section presents the main results, while the last section concludes.

Literature review

The European Commission has assessed implementation and effectiveness of the various greening measures in 2015 and 2016. The first review was focused on issues such as the implementation of greening measures and whether they created a level-playing field, as well as their production potential (EC, 2017b). In 2015, agricultural land subject to at least one green direct payment obligation amounted to 72% of the total EU agricultural area. In the case of Poland, this indicator amounted to over 80%. This area demonstrates the potential of green direct payments in delivering of environmental and climate benefits on a large share of the EU farmland. "The proportion of farmers under at least one greening obligation stands at around 36% of direct payment beneficiaries" (EC, 2016: 5). In 2015, the most frequently declared EFA types were those linked to productive or potentially productive agricultural areas: nitrogen-fixing crops and catch crops that reached 54% of the total weighted EFAs (39% and 15% respectively, after applying the weighting factors), and fallow land. This was 5.4 % of the arable land under the EFA obligation (EC, 2017a: 8). In 2016, in the second year of greening implementation, the data suggested little change in comparison to 2015. Conversely, if one takes into account the level of difficulty for fulfilling specific greening requirements – the actual environmental improvement depends on the environmental ambition of the measures taken, which vary across EU Member States[4].

The evaluation based on international research (carried out after only two years of implementation of the greening measures, looking at the effects of the greening measures compared with the situation in 2014) indicated, that overall the greening measures have led to only small changes in management practices, with the exception of a few specific areas. The greening mechanism made only a low contribution towards promoting more sustainable farming practices and had a negligible effect on production or the economic viability of farms (EC, 2017a). "As currently implemented, it is unlikely to enhance the CAP's environmental and climate performance significantly" (European Court of Auditors, 2017a:1). Research based on modelling echoed this argument, indicating that in present form, the environmental impacts are rather limited and will not contribute much to improving the CAP provision of public goods (e.g. Solazzo *et al.,* 2015; Cortignani *et al.,* 2017; Gocht *et al.,* 2017). There are indications that the CAP greening needs to be redefined and regionalised to ensure the transition towards 'greener' agriculture (Galán-Martín *et al.*, 2015). "However, the proponents of CAP greening argue that the inclusion of such measures is first political step to 'open the door' for the future adoption of novel agricultural policy measures promoting a better environmental performance of the EU farming sector" (Louhichi *et al.,* 2018).

Another important strand of the literature in this topic analyses the relationship between greening and the production potential of agriculture. Preliminary studies indicated that the effect of green direct payments on land use and agricultural production is generally projected to remain very low over the medium term, with the noticeable exception of a slight increase in the share of permanent grassland, fallow land and protein grain production compared with a situation without green direct payments (EC, 2016:15). This is the basis for the claim that at present there is no competitive relationship between the environmental and production purposes of the greening mechanism. However, first models in this regard indicated the reduction of agricultural outcomes in the short run and the increase of production costs in the long run as side effects of greening (Matthews, 2011). Scenario modelling approach showed a reduction of production and an increase in the prices of agricultural products (Cantore, 2012), while the CAPRI model results indicated a slight reduction in farm productivity (Gocht *et al.,* 2016).

An assessment of likely CAP greening effects in Poland was already undertaken at the stage of preliminary administrative proposals (Czekaj *et al.,* 2012; Czekaj *et al.,* 2014). The analysed greening scenarios indicated that the environmental restrictions concerned only a minor part of farms and they would have little impact on their operation and outcomes. There have also been scientific papers based on the public statistics data in order to identify the effects of greening in Poland (Wąs and Jaroszewska, 2017; Wąs and Jaroszewska 2017b), although applied methodology so far have not been able to separate external factors affecting Polish farms after greening.

On the whole, the majority of international research concerning the effects of greening is very general (EC, 2016;

[4] See (EC, 2017d).

EC 2017; Hart, 2015; Hart *et al.,* 2016), with these comprising changes in the agricultural sector, at both the country and the EU levels. Studies taking into account the performance of farms generally were based on model solutions, since the available data did not allow an assessment of the actual effects of greening (Galán-Martín *et al.*, 2015; Louhichi *et al.,* 2018).

The results of studies commissioned by the European Commission, which involve international comparison, highlight the problem of the effectiveness of greening[5]. Therefore, this also underlines the need to precisely examine practices related to the implementation of greening in individual Member States, taking account of the organisation of agricultural production both on farms under the greening obligation and farms exempted from it, and factors that have determined it, also prior to the introduction of this mechanism[6]. The evaluation of the effectiveness of greening is the basic determinant for the continuation and possible modification of this mechanism in the next Common Agricultural Policy programming period.

Methodology

Concerning the above, there is high need for accurate selection of groups of farms which were obliged directly to implement the greening requirements, in order to identify the actual first effects of greening. Agricultural accounting data have made it possible to conduct such research, with the selection of targeted farms, to monitor organisational, production and economic effects of the analysed legal rules. From 2015, Polish agricultural accountancy data resources have provided detailed identification of farmers' actions covered by the mechanism of greening[7]. The proposed research approach presented in the paper is an example of agricultural accounting data used in the context of greening, which can be developed on the basis of other EU countries data sources.

The paper is based on the panel of 7.4 thousand private farms included in the Farm Accountancy Data Network (FADN), both in 2014, and 2015. FADN data allow an analysis of agricultural holdings situation, both in terms of organisation and production, as well as economic performance. Individual agricultural accounting data allow researchers to recognise the actual situation of agricultural holdings, selected according to the adopted justified criteria. In contrast to the model approach, the actual FADN data enable the farms' state in the studied range to be represented with high precision.

From 2015 Polish FADN has introduced an additional questionnaire survey on the effects of the greening mechanism, which has been in force since the introduction of the new legal rules connected with agro-environmental practices (EC, 2016b). In accordance with the Commission Implementing Regulation, there was a transitional period between 2015 and 2017 for detailed information on greening (EFA elements), (Official Journal of the European Union L. 46/1, 2015). In the case of the Polish FADN, detailed information has been already collected since 2015, enabling detailed analysis of greening in the first year of its implementation. Polish FADN took into account both formal greening requirements, including individual practices of this mechanism and exemptions (FADN, 2018). There was the same agricultural holdings` panel (and farms` groups panel) chosen for the research, taking part in agricultural accounting in the year before the introduction of greening (2014) and in a year when greening was already formally in force (2015). Additionally, as recent studies have indicated (MRiRW, 2016; Kowalski, 2018) natural, institutional and market conditions as expected did not diversify the production situation in Polish agriculture in 2015, as compared to 2014. National legislation on agriculture in 2015, was also not a factor differentiating the farmers` production decisions, as compared to 2014. Therefore, thanks to the deliberate choice of agricultural holdings in accordance with the greening requirements, the changes that have occurred in these farms, with high probability, can be identified as correlating and/or caused by the new greening mechanism based on deduction reasoning.

All analysed farms participated in Single Area Payment Scheme. The study omitted agricultural holdings exempted from greening on the basis of general principles (e.g. organic farms, farms with high share of permanent grassland, etc.) and those applying the equivalent practices. Greening mechanism focuses on production organisation on arable land, hence the studied farms' population does not include entities lacking this land type.

The farms' panel selection made it possible to identify organisational changes in agricultural production after the introduction of greening in 2015, compared with 2014, that is the year when the greening mechanism was not in force. The farms' panel was divided into two groups, namely: small farms, not obliged to greening fulfilment (below 10 ha of arable land) and those farms, obliged to greening (with an area of at least 10 ha of arable land). The second group was additionally divided into two sub-groups, namely smaller farms (10-15 ha), which are required to crop diversification, as well as larger farms (15 ha or more), which in addition to diversification of crops, should also ensure adequate surface of EFA.

Classifying the analysed farms' panel in this way made it possible to indicate agricultural production changes, which were mainly organisational, depending on the scope of the existing administrative requirements related to the mechanism of greening. Both farms obliged to greening and those exempted from the obligation (the control group) were analysed in the scope of agricultural production organisation to identify the actual impact of the administrative instrument and symptoms of those changes, beyond the formal requirements. Identification of agricultural production organisation in farms exempted from greening makes it possible to assign observed changes (or the maintenance of *the status quo*) to other conditions of farms' operation, beyond the administrative mechanism of greening. As a complement to the study, there were illustrated the production and economic results of analysed farms' groups. Precise evaluation of farms' results requires further analysis based on the data from subsequent years.

Due to the fact that since 2015, the FADN system has been registering the practices that are applied on farms under

[5] Comparison of greening effects in different European countries is presented in: (EC 2016; EC, 2017d; Hart *et al.*, 2016).

[6] Papers that concern the implementation of greening in Poland in 2015, see e.g. (Wrzaszcz 2017a, Wrzaszcz 2017b).

[7] See: (EC, 2016b).

the greening mechanism in order to identify actual farming practices related to EFA maintenance, a population of farms with at least 15 ha of arable land that are covered with this requirement has been singled out. The 2015 population of farms with EFA area amounted to 4,700, while the population of farms keeping agricultural accounts consisted of 12,105 private farms.

Farms' number and land use

The studied population of 7,392 farms was dominated by those that were under the greening obligation (77%, Figure 1, left). The population of farms under the greening requirements amounted to 5,705, and the majority of these farms were larger farms, i.e. farms with the minimum of 15 ha of arable land. Larger farms are obliged to comply with the greening requirements in regard to both crop diversification and maintenance of ecological focus areas. The importance of this group of farms results from their total area. In the case of the studied panel, the farms with at least 15 ha of arable land held over 90% of area.

The greening requirements basically refer to the manner of arable land use but also involve monitoring related to the maintenance of permanent grassland. Therefore, this study has focused on both the classification of land in the identified groups of farms and on the changes in this regard (Table 1).

The arable land area in farms under the greening obligation was comparable in the analysed years. In the case of smaller farms (10-15 ha), the fallow land area and change to it was small in physical terms and resulted in a small reduction in crop area. However, the larger farms (15 ha or more) increased their arable land area, including the fallow land (by nearly 50%)[8]. In the latter group, the additional land was put to use in 2015. The increase in this area was related to the adjustment of the larger farms in order to comply with the EFA maintenance. Driven by the aim of increasing the area of ecological focus, the farmers increased the farm area by including additional fallow land and at the same time maintained the area used for crop production[9]. The farmers purchased or leased the land that had not previously been used for agricultural purposes.

In the case of farms exempted from greening (ones with less than 10 ha), the area of arable land in use and permanent grassland was comparable in the analysed years. The fallow land area was a minor portion of their area. Their area increased to an extent that is definitely smaller than in the case of farms obliged to maintain EFAs.

What needs to be emphasised is the fact that the farms exempted from greening strongly differed from the larger ones in terms of land use. In the former group, permanent grassland took as much as a third of the agricultural land area, which determines their significance in terms of the carbon sequestration capacity, soil production potential and biodiversity. On the other hand, among farms under greening obligation, the percentage of permanent grasslands was significantly lower (21% for farms with 10–15 ha, and 9% for farms with 15 ha or more). These figures show that it

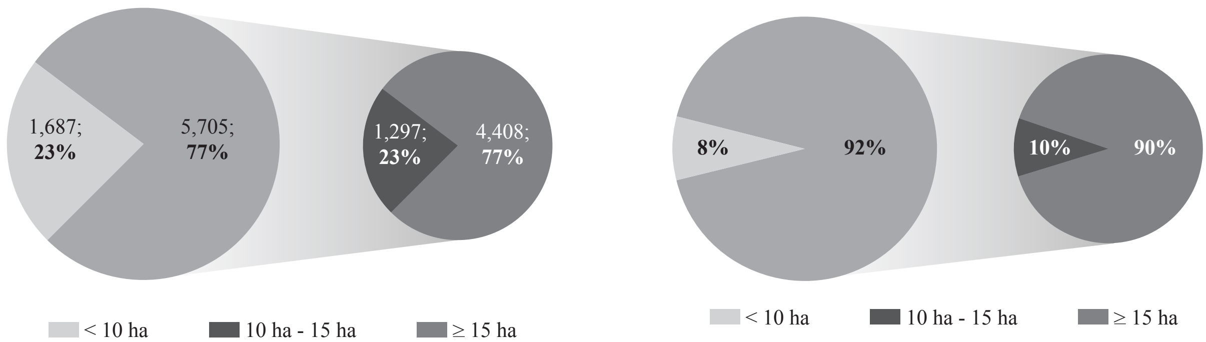

Figure 1: Structure of farms` number (left) and agricultural land (right) by area farms` groups in 2015.

Source: own composition based on FADN data 2015.

Table 1: Land use in not obliged and obliged farms to greening (in ha).

No.	Specification	2014	2015	Change (in ha)	2014	2015	Change (in ha)	2014	2015	Change (in ha)
		≤10 ha			10-15 ha			≥15 ha		
1	Arable land	14,168	13,870	-298	19,491	19,286	-205	205,904	208,570	2,666
2	Fallow land	229	274	45	145	170	25	985	1,472	487
3	Orchards	1,565	1,597	32	308	322	14	705	701	-4
4	Permanent grassland	7,667	7,786	119	5,192	5,186	-6	20,131	19,457	-674
5	Agricultural land	23,400	23,253	-147	24,990	24,794	-196	226,739	228,729	1,990

Source: own composition based on FADN data for 2014-2015.

[8] In physical terms, however, this area was small and amounted to mere 0.7% of arable land area.

[9] Compare with results for farms population in Poland, presented in: (Wąs and Jaroszewska, 2017).

is reasonable to vary the greening requirements depending on the farm's area and structure of agricultural land because on the smaller farms, the percentage of grassland is higher (on average) – it is a particularly important natural habitat for both the preservation of species and the continuity of natural processes. From this perspective, larger farms, where larger area is used for crop production through arable land use, should ensure its organisation so that it is favourable for generating environmental benefits resulting from the agricultural practice. However, the substitution scale of permanent grassland maintenance and proper management of arable land is an open question.

Arable land use

The fulfilment of the crop diversification and EFA requirements correlates to a specific cropping pattern. Therefore, analysis of the cropping patterns on arable land has to pay attention to the varieties and groups of main crops and catch crops.

In accordance with the greening requirements, farms under the crop diversification obligation should grow at least two crop species. According to the legal rules, spring and winter crops are treated as separate species. As shown in Table 2, inclusion of spring and winter varieties to a large extent allowed the crop diversification requirement to be satisfied, particularly in the case of farms with 10–15 ha. The high value of winter cover ratio makes it possible to state that the organisation of crop production to a large extent had complied with the crop diversification requirement a year before it was introduced. The observed cropping pattern in regard to winter cover on arable land was more favourable on large farms than on smaller farms (in 2015, the percentage of area under winter crops in these two groups was 57% and 40% respectively). Farmers had numerous options allowing them to ensure the required number of cultivated crop species, which shows the great flexibility of the greening instruments. The farmers' selection in this regard was determined primarily by the organisation of crop production in 2014, i.e. just before the imposition of greening. The maintenance of cropping patterns that take account of the relevant proportion of spring and winter crop varieties in 2015 resulted in the exemption of farmers from the obligation to introduce significant organisational changes to crop production. It can be stated that greening contributed to the continuation of the favourable status quo regarding the winter vegetation cover. In this respect, greening can be considered effective.

In the case of the smallest farms exempted from the greening obligation (below 10 ha), the winter crop area was definitely lower compared to the farms under the obligation because these crops took as little as a third of the crop area on arable land. Also, when comparing 2015 to 2014, there is no favourable change in this regard. Farmers utilising a small arable land area are not legally bound to diversify their crops, and they are also not motivated to increase the winter crop area.

The cropping patterns of farms under greening obligation were dominated by cereals (as of 2015, in the case of the 10–15 ha farms, the percentage of cereals was 69%, while in the case of farms with 15 ha or more it was 65%). The percentage of cereals slightly dropped, when comparing 2015 to 2014 (about 2 percentage points). When assessing the cropping patterns of an average farm under greening obligation, it can be stated that the proportion of other crops, including soil-improving crops, i.e. pulses and papilionaceous crops is negligible – in total, they amount to just a few per cent. However, pulses and papilionaceous crops, both edible species grown for grain and fodder crops, are an important element of the cropping pattern, which has favourable impact on the

Table 2: Crops in not obliged and obliged farms to greening (in ha, change in %).

No.	Specification	2014	2015	Change (in %)	2014	2015	Change (in %)	2014	2015	Change (in %)
		≤10 ha			10-15 ha			≥15 ha		
1	Winter crops (for the next year)	4,525	4,654	103	7,791	7,739	99	113,782	117,858	104
2	Catch crops	266	198	74	386	318	82	5318	11,343	213
3	Cereals	9,133	8,753	96	13,581	13,177	97	136,619	134,087	98
4	Pulses for grain	350	542	155	396	683	172	6,305	11,456	182
5	Pulses for grain: edible	32	46	144	40	112	280	436	1,333	306
6	Pulses for grain: fodder	199	372	187	197	413	210	2,975	7,488	252
7	Fodder: field pea	22	28	127	47	71	151	383	1,154	301
8	Fodder: horse bean	10	30	300	22	49	223	234	801	342
9	Fodder: sweet lupine	105	204	194	87	229	263	2,058	4,931	240
10	Pulses for grain: pulse mixes with others	119	124	104	158	158	100	2893	2,635	91
11	Industrial crops	542	522	96	1,202	1,150	96	37,825	36,800	97
12	Potatoes	447	411	92	620	548	88	3,387	3,434	101
13	Fodder crops	2,614	2,669	102	3,069	3,206	104	17,260	18,931	110
14	Fodder crops: Grasses	611	663	109	508	612	120	2,380	2,834	119
15	Fodder crops: Pulses	11	31	282	27	20	74	99	200	202
16	Fodder crops: papilionaceous	99	119	120	144	196	136	839	1,383	165
17	Fodder crops: papilionaceous mixes with grasses	746	662	89	451	344	76	2,757	2,311	84

Source: own comparison based on FADN data 2014-2015.

Table 3: The main EFA elements (in 2015).

Elements	Farms		Surface EFA			
	Number	%	Converted (ha)	Weighed (ha)	Converted (%)	Weighted (%)
EFA14a: stubble catch crops	2,707	57.1	16,749	5,025	54.2	34.2
EFA15: nitrogen-fixing crops	2,229	47.0	11,173	7,821	36.1	53.2
EFA14b: winter catch crops	275	5.8	1,610	483	5.2	3.3
EFA1: fallow land	228	4.8	804	804	2.6	5.5
EFA in total	4,744	n.a.	30,910	14,699	100	100

Source: own composition based on 2015 FADN data.

soil organic matter, and in turn on the soil productivity. This is a reason for considering the papilionaceous crops as an ecological focus area. When comparing 2015 to 2014, there is a need to observe that the area of soil-improving crops significantly increased, which was particularly observable on larger farms[10]. These changes occurred both on smaller farms, which selected pulses for the sake of crop diversification, and the larger ones, which were in addition obliged to ensure EFA. In the case of larger farms – 15 ha or more – the area of edible and fodder pulses for grain grew 3 and 2.5 times respectively.

Another important element of the cropping pattern were fodder crops, particularly papilionaceous crops and pulses for green fodder and grasses on arable land. In the case of the farms under greening obligation, their area on average increased over 1.5 times. Operators of larger farms, i.e. farms with 15 ha of arable land or more, were more active in this regard. These results show the impact of legal regulations related to greening, including ones concerning the maintenance of EFAs, on decisions made by farmers in regard to the area of soil-improving crops.

The cropping patterns of farms exempted from greening were also dominated by cereals (65% in 2015). In the case of these farms, a relatively larger crop area was under fodder crops (particularly fodder maize, field grass and papilionaceous mixes and multi-species mixes). The smaller farms tend to combine crop and livestock production, which also determines the manner of arable land use. The dynamic of changes in pulses area, however, did not equal the ones observed in the case of farms under greening obligation.

As shown by the presented figures, the farms not legally obliged to diversify their crops and maintain EFAs also follow the same course in the reorganisation of crop production, but they differ in its dynamic. The increase in the area of pulses and papilionaceous crops can surely be attributed to greening, but it is not the sole determinant. In this context, there is a need to stress the importance of other instruments, such as the agri-environmental programmes, or direct support for soil-improving crop production, which have been encouraging farmers to cultivate crops in a symbiosis with natural environment[11]. The additional incentive in the form of the greening payment surely incentivised farmers to make the desired and more dynamic changes to their farms.

Apart from the change to the area of main crops, there was also a change to the area of catch crops. Catch crops are one of the most important elements forming the agricultural EFA. Their importance results from the soil-improving and protective properties, but they can also be used as fodder. As shown by the data, catch crops supplemented the cropping patterns in farms under the greening obligation, but their area significantly grew in 2015 in the case of the larger farms (obliged to ensure EFAs). In the case of those farms, the percentage of catch crops increased from 2.6% to 5.5%, when comparing 2014 and 2015. On the smaller farms, however, this area dropped, which indicates the significance of the greening mechanism. In the case of farms exempted from greening, catch crops were grown on an even smaller area, which significantly dropped in 2015 compared to 2014 – by 25%. Thus, the percentage of catch crops in the cropping patterns dropped from 1.9% in 2014 to 1.5% in 2015. Presented changes in the cropping patterns and the catch crop area (growth on the larger farms and drop on the smaller farms) indicated that the greening effectively encourages farmers to maintain EFAs through agricultural practices. Farmers not legally obliged to grow catch crops didn't introduce organisational changes aimed at increasing this crop area.

EFA specification[12]

The applicable legislation specified many different elements of EFA, that are related to agriculture, forests and landscape[13]. In accordance with the specification, most of these elements concern landscape, while some of them are related to the organisation of plant production, i.e. the use of catch crops and companion crops, as well as the cultivation of nitrogen-fixing plants. The farmer can decide which elements are to be used to comply with the EFA requirement. In 2015, total EFA in farms keeping agricultural accounting was 15,000 ha[14], which accounted for 6.5% of arable land (tab. 3). This number shows that the analysed farms fully complied with the requirement to maintain EFA (taking into account the result for the entire analysed farms` group).

As indicated in Table 3, farmers concentrated on suitable plant production, adjusted to environmental requirements,

[10] See (Wąs and Jaroszewska 2017a). The same direction of changes was observed for population of farms in Poland. The different influences of soil improving crops on biodiversity need to be outlined (Hart *et al.,* 2016).

[11] The observed direction of the sown area change in Poland, indicated the influence of the CAP instruments, that support the production of protein crops in recent years. The increase in surface of these plants from 2010, was associated with the area direct payments (Wąs and Jaroszewska 2017b). The more dynamic growth of this surface took place in 2015. The presented figures indicated that, in addition to area direct payment for the protein crops, greening had the essential importance in farmers` production decisions, which provided an extra boost to the increase of soil improving crop cultivation.

[12] See (Wrzaszcz, 2017a).

[13] See footnote No. 5.

[14] This area refers to the weighted area. Due to different environmental significance of the various EFA elements (agricultural and landscape ones), an EFA weighted area is given (MRiRW, 2016).

Table 4: Outcomes, subsidies and their relation*.

No.	Specification	2014	2015	Change (in %)	2014	2015	Change (in %)	2014	2015	Change (in %)
		≤10 ha			10-15 ha			≥15 ha		
1	Total output (1000 euro/ha)	1,93	1,99	103	1,73	1,65	95	1,57	1,47	94
2	Total output (1000 euro/AWU)	14,69	15,30	104	18,48	17,62	95	39,16	37,14	95
3	Gross farm income (1000 euro/ha)	1,00	1,14	114	0,85	0,87	102	0,78	0,76	97
4	Gross farm income (1000 euro/AWU)	7,66	8,72	114	9,08	9,27	102	19,38	19,31	100
5	Income (1000 euro/ha)	0,67	0,79	118	0,59	0,60	102	0,56	0,54	96
6	Income (1000 euro/FWU)	5,08	6,08	120	6,29	6,40	102	14,08	13,74	98
7	Direct Payments/Subsidies (%)	65	70	5 p.p.	69	75	6 p.p.	63	71	9 p.p.
8	Single Area Payments/ Subsidies (%)	52	57	5 p.p.	57	61	4 p.p.	56	61	5 p.p.
9	Subsidies/Output (%)	16	17	1 p.p.	15	19	3 p.p.	17	21	4 p.p.
10	Subsidies/Income (%)	54	49	-5 p.p.	50	57	7 p.p.	53	65	12 p.p.
11	Balance Subsidies and Taxes/Income (%)	38	37	-1 p.p.	38	46	8 p.p.	38	49	11 p.p.

* 1 AWU/FWU is the equivalent of the full-time labour of all workers/only farming family members. All production and economic categories in current prices; p.p.– in percentage points.
Source: own studies based on FADN data 2014-2015.

and only few of them selected landscape and forest elements (these accounted for just a few per cent of the total EFA). A total of 87% of the weighted ecological area was used for stubble catch crops and the cultivation of nitrogen-fixing crops. Farmers did not diversify EFA – one or two EFA types were selected most often on the farm level (which was done by 94% of farms). Farmers' choices related to meeting the EFA requirement by plants cultivation in the main crop and secondary crop translated into a change in the cropping pattern in their farms, thus improving water and soil conditions.

These results demonstrate the importance of the agricultural elements of EFA in the context of compliance with this requirement of the EU law. The farmers' selection of specific EFA elements could have been imposed to a large extent by the administrative requirements related to specific elements of ecological focus area. Particular difficulties that a farmer faced were related with keeping the registration of specific landscape elements. Pursuant to the administrative requirements, there is an obligation to measure and illustrate the size of each EFA element, which also involves its presentation on the maps. An important issue is the preparation of an up-to-date record of valuable natural resources in Poland, including their location on farms under the EFA obligation. The results can indirectly indicate a small proportion of valuable landscape and forest features compared to the utilised area on larger farms.

Farms' outcomes[15]

Analysing the impact of greening on the farms` organisation, there is a need to mention their production and economic outcomes. The results of the analysed farms have been illustrated both through the factor productivity and profitability indicators and the subsidies absorption (Table 4)[16]. The data presented should be regarded as a recognition that farms' production and economic situation differ according to the scope of their greening requirement implementation. Due to administrative decisions related to the earlier payment of advances on direct payments in 2015, it is not possible to quantify precisely the economic effects in the first year of the greening implementation. Detailed diagnosis also requires additional price analysis of agricultural products variety. It should be underlined that greening was not associated with higher subsidy value for farmers, but was a necessary condition to get a part of direct support. However, organisational changes associated with greening can also have an impact on the agricultural production volume, its sort structure and final value. Thus, greening's influence on the farms' outcomes can be assessed indirectly. As indicated by the figures in Table 4, the final economic outcome of the agricultural producer to a comparable extent depended on the value of agricultural production and the size of the support in the form of subsidies.

With farms under the greening obligation, the productivity of production factors slightly dropped, while their profitability was comparable in the analysed years, both in the case of the smaller (10–15 ha) and the larger ones (15 ha or more). The amount of the granted subsidies has to be seen otherwise – this value grew significantly in 2015 compared to 2014 – by 18%. The increase in the subsidy transfer should be attributed primarily to the administration decision (scope of and criteria for the granting of subsidies, and the introduction of advance payments related to direct payments) and then to the farmer (their greater activity). It has to be remembered that in 2015, the first year when greening was implemented, only a small percentage of the beneficiaries actually received the related payment. The role of the administrative decision that granted advances of direct payments to farmers in late 2015 (MRiRW, 2015) also needs to be acknowledged: i.e. it took place much earlier than in the previous years. Subsidy

[15] According to FADN data, the average exchange rate in 2015 was EUR 1 = PLN 4.18.

[16] Categories and definitions of standard results of farms were presented in: (Floriańczyk *et al.,* 2017).

transfers for the preceding years were basically made in the following year17.

When comparing 2015 to 2014, it can be stated that the role of subsidies contributing to the economic situation of farms under the greening obligation increased, which is shown e.g. by the higher ratio of payments to farm production value. In 2015, nearly half of the farm income came from that source, while in 2014, its share was 38%[18]. The presented figures indicate that the funds in the form of subsidies now exert an increasing impact on the economic condition of farms, particularly in the case of larger farms. In addition, this phenomenon has recently become more visible.

Productivity of production factors on the farms exempted from greening was comparable in the analysed years, and the profitability rations grew significantly (from a dozen or so per cent for added value to 20% in the case of income when comparing 2015 to 2014), which has not been observed in the case of farms under the greening obligation. The subsidy to production ratio indicated that the economic situation of the farms exempted from greening was less dependent on the cash flows from subsidies compared to the farms under the greening obligation. The studied years also saw a decline in the importance of such subsidies for the economic performance of farms below 10 ha.

Main conclusions

This paper has discussed the effectiveness of greening scheme in Poland. The changes that occurred on farms after new requirements introduction were evaluated on the bases of 2014-2015 Polish FADN data. The first year of analysis presented the farms` state before the implementation of greening, while the next year showed the situation when the requirements came into force. This analysis has been supplemented by a parallel analysis of farms exempted from that obligation, which were used as a control group. Comparison of results for farms under the greening obligation (at least 10 ha of arable land) and exempted from it (below 10 ha of arable land) enabled the identification of organisational changes to farms that were introduced as a consequence of the new administrative solutions.

The main conclusions from the study, which refer to the analysed group of Polish FADN farms and legal regulations related to greening that have been binding on farmers since 2015:

1. Greening requirements related to land use had no adverse impact on the production potential of farms.
2. The different structure of agricultural land in use has indicated that it is reasonable to diversify the environmental requirements imposed on smaller and larger farms.
3. Farms with at least 15 ha of arable land took the most organisational measures to adjust to the new administrative requirements. This state of affairs corresponds to the assumed impact of the greening mechanism, which confirms its effectiveness.
4. The environmentally friendly organisation of Polish farms before the introduction of the greening requirement allowed them to adjust smoothly in 2015.
5. Maintaining the status quo on farms (as regards winter crop) or the introduction of desired organisational changes to crop production is the quintessence of the measures related to the meeting of the greening requirements. In this aspect, greening can be considered effective.
6. In the context of pulse and papilionaceous crop areas increasing, there is a need to stress the importance of greening, but also the agri-environmental programmes and direct support for soil-improving crops, which have been encouraging farmers to cultivate crops in a "symbiosis" with the environment.
7. The farms not legally obliged to diversify their crops and maintain EFAs also follow the same course in the reorganisation of crop production, but they differ in terms of its dynamic. The more favourable dynamic of such changes on farms under the greening obligation demonstrates the effectiveness of the mechanism.
8. Maintenance of EFAs on farms requires basically an appropriate crop production organisation. It is reasonable to carry out administrative work aimed at simplifying the procedures related to the listing of landscape and forest elements, to encourage farmers to preserve them.
9. Another issue that should be considered important is the determination of substitutability of different agricultural practices in terms of the environmental impact and maintenance of natural resources at the farmers' disposal.
10. The extent to which the "desired" agri-environmental practices are implemented should serve as a basis for assessing the environmental effectiveness of greening. As indicated in the discussion presented in the academic literature, the environmental effects of greening are deemed insufficient due to the adopted greening requirements.
11. In the first year of the implementation of greening, these requirements did not adversely impact the production and economic performance because the area allocated to the ecological focus areas amounted to mere several per cent of the area in use and the crop diversification criteria did not force any significant organisational change in crop production.

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[17] In 2015, the advances of direct payments were paid for the first time. These advance payments, at 50% of the total payment, were paid in advance of: the Single Area Payment, additional payment, protein crop payment, and the soft fruit payment. In total, about 80% of the direct payment beneficiaries received such advances (MRiRW, 2016).

[18] Also including tax liabilities.

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Who Benefits from the Export Tax Rebate Policy? Evidence from the Chinese Fishery Sector

The export tax rebate policy in China is under dispute, especially in agricultural sectors, as it is claimed that it works as a subsidy for foreign consumers rather than domestic producers. Surprisingly, little research has investigated the distribution of benefits of this policy. In this paper, we examine this in a partial equilibrium framework. We find that the effects of the export tax rebate on domestic producers depend on the relative magnitude of the export supply and import demand elasticities. The model is then applied to the Chinese fishery sector, a perfect example to illustrate the policy debate. Simulation results indicate that, although the export tax rebate increases Chinese producers' welfare, foreign consumers capture most of its welfare benefits (60%-75%). Furthermore, the results imply that the welfare gain for Chinese producers is overestimated if the vertical linkage between the retail and the farm markets is ignored.

Keywords: Welfare Distribution, Export Tax Rebate, Value-Added Tax, Fishery Sector, Retail market, Farm Market

JEL classifications: F13, Q17, C63

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Introduction

China first implemented the export tax rebate policy in 1985. This policy enables export companies to get a partial or total refund for the indirect tax paid during the production and distribution processes. In the agricultural sectors, the export tax rebate is implemented not only in order to provide the exporting firms with a higher profit, but also in order to enhance the income of farm producers. This is due to the connection between the retail and farm markets, and thus the tax rebate is considered to alleviate the poverty of China's rural population (which accounted for 50.32% of the total population in 2016, according to FAO data).

However, this policy imposes a heavy fiscal burden on the Chinese government, and the large size of the rebates can be said to crowd out government expenditures on education, social security, etc. (Cui, 2003). An export tax rebate can be split between an increase in the domestic price and a reduction in the export price, and thus improves foreign consumers' welfare. Many financial commentators point out that in some industries, the tax rebate is decreasing the export price to a larger extent than increasing the domestic supply price. Hence it works more to subsidise foreign consumers than domestic producers. As a result, the debate over whether this policy should be abolished in certain sectors continues.

The effects of the export tax rebate have attracted much attention in the literature. Most studies find a positive relationship between the tax or tariff rebate and exports (Chao et al., 2001; Chandra and Long, 2013; Chen et al., 2006; Gourdon et al., 2017), except for one case in the agricultural and food industry (Chao et al., 2006). However, when it comes to welfare effects, studies on export tax rebates or export subsidies mainly focus on the whole country's welfare (e.g., Brander and Spencer, 1985; Chao et al., 2006; Jarvis, 2012; Yin and Yin, 2005). Few discuss how the welfare gains or losses are distributed among different groups in a specific sector, including domestic producers, domestic consumers, and foreign consumers at the retail level, or among suppliers of different inputs. An export promotion policy (such as an export subsidy or export tax rebate) increases the domestic price and thus, according to the price theory, such a policy improves the domestic producers' welfare at the expense of domestic consumers' surplus. However, is it possible that the beneficiaries are foreign consumers, instead of domestic producers? What affects the welfare distribution effects of such policy? Moreover, in an agricultural sector, how does such a policy affect the farm and non-farm input producers? As mentioned before, the export tax rebate imposes a heavy fiscal burden on the government, and may be detrimental to domestic consumers; thus, it is important to address these questions.

This paper attempts partially to fill this gap by simulating the incidence of the export tax rebate, including the price effects and the distribution of welfare gains among different groups in an agricultural sector with a partial equilibrium approach. Then, the model is applied to the Chinese fishery sector, which provides a typical context for the disputes on the export tax rebate policy. In 2008, the rebate rate for several types of fishery products[1] was increased from 5% to 13%. Critics have pointed out that the export tax rebate is subsidising foreign consumers and that domestic producers are getting few benefits, and thus this policy results in a waste of taxpayers' money.

In this paper, we first use an equilibrium displacement model (EDM) to investigate the effects of the export tax rebate on prices and trade flows. EDMs are widely used to evaluate the effects of exogenous shocks in food and agriculture sectors, especially those caused by government policies (Dhoubhadel et al., 2015; Gardner, 1975; Kinnucan and Cai, 2011; Leister et al., 2015; Wohlgenant, 1989). Then, following the method of Sun and Kinnucan (2001), we calculate the distribution of welfare changes for Chinese domestic producers, domestic consumers, and foreign consumers using the EDM simulation results.

[1] They include frozen tilapia, frozen tilapia fillets, frozen crustacean, molluscs, etc.

Although the policy is implemented at the retail level, we also consider the farm level and the linkage between the two levels, as not considering such vertical linkage may produce inaccurate results. In this paper, Wohlgenant's (1989) method is followed since the retail and the farm markets are linked through the retail price and the farm price. In this way, we are able to obtain not only more accurate results for the retail market, but also a realistic estimate of the benefits' allocation between producers of farm and non-farm inputs at the input level.

Methodology

Model

Consider a simplified situation in which retail producers purchase inputs from the farm market to produce a homogeneous product and sell them in both domestic and export markets. An export tax rebate is implemented in the retail market for the export goods. The industry is assumed to be competitive within the country[2] and the Law of One Price holds. The economy is large in that it affects the world price. Ignoring all tariffs and other trade barriers, the initial equilibrium of an agricultural sector can be defined as follows:

Retail market:

$$D_R = D_R(P_R^D) \quad \text{(Domestic demand)} \quad (1)$$
$$P_R^S = P_R^S(S_R, P_F, P_N) \quad \text{(Inverse supply)} \quad (2)$$
$$X_R = X_R(P_R^X) \quad \text{(Export demand)} \quad (3)$$
$$P_R^D = P_R^S \cdot VAT \quad \text{(Domestic price)} \quad (4)$$
$$P_R^X = P_R^S \cdot VAT/ETR \quad \text{(Export price)} \quad (5)$$
$$S_R = D_R + X_R \quad \text{(Market clearing)} \quad (6)$$

Farm market:

$$P_F = P_F(D_F, P_R^S, P_N) \quad \text{(Inverse demand)} \quad (7)$$
$$S_F = S_F(P_F) \quad \text{(Supply)} \quad (8)$$
$$S_F = D_F \quad \text{(Market clearing)} \quad (9)$$

In this model for China, D_R and S_R are the retail-level domestic demand and supply, respectively; X_R is the retail-level export; P_R^D is the retail-level domestic demand price; P_R^X is the retail-level export price; P_R^S is the retail-level supply price; D_F and S_F are the farm-level demand and supply, respectively; and P_F is the farm-level price. The variables *VAT* and *ETR* represent the value-added tax and the export tax rebate[3], respectively. Then, an isolated increase in *VAT* increases both domestic and export prices, while an isolated increase in *ETR* increases the domestic price and reduces the export price. Finally, P_N is the price of non-farm inputs. The retail- and farm-level markets are linked by the domestic retail-level supply equation and the farm-level demand equation. Overall, this model contains nine endogenous variables (D_R, S_R, X_R, P_R^D, P_R^X, P_R^S, D_F, S_F, and P_F) and three exogenous variables (*VAT*, *ETR*, and P_N).[4]

By taking the total differential, the model can be written in the equilibrium displacement form, which characterizes the change in equilibrium prices and quantities from shifts in *VAT* and *ETR*, as follows:

Retail market:

$$D_R^* = \eta_R^D P_R^{D*} \quad (10)$$
$$P_R^{S*} = S_R^*/\varepsilon_R + \phi_{RF} P_F^* + \phi_{RN} P_N^* \quad (11)$$
$$X_R^* = \eta_R^X P_R^{X*} \quad (12)$$
$$P_R^{D*} = P_R^{S*} + VAT^* \quad (13)$$
$$P_R^{X*} = P_R^{S*} + VAT^* - ETR^* \quad (14)$$
$$S_R^* = k_D D_R^* + k_X X_R^* \quad (15)$$

Farm market:

$$P_F^* = D_F^*/\eta_F + \phi_{FR} P_R^{S*} + \phi_{FN} P_N^* \quad (16)$$
$$S_F^* = \varepsilon_F P_F^* \quad (17)$$
$$D_F^* = S_F^* \quad (18)$$

Here, the asterisked variables refer to approximate relative changes (e.g., $P_F^{D*} = dP_R^D/P_R^D$,). Parameters are defined in Table 1. For normal sloping supply and demand curves, $\eta's < 0$ and $\varepsilon's > 0$.

The distribution of benefits brought by the export tax rebate can be measured in two ways: by the passing on of the export rebate to Chinese producers and foreign consumers and by the welfare distribution among each group.

The pass-through of the export tax rebate

By imposing the market clearing conditions and dropping equations (12) and (14), China's export supply equation can be obtained as follows:

$$X_R^* = \varepsilon_R^X P_R^{S*} + \varepsilon_F^X P_F^* + \varepsilon_N^X P_N^* - (k_D \eta_R^D / k_X) VAT^* \quad (19)$$

where $\varepsilon_R^X = (\varepsilon_R - k_D \eta_R^D)/k_X$ is China's export supply elasticity with respect to the retail supply price. For normal parameter values, $\varepsilon_R^X > 0$, indicating that the increase in the supply price increases the export supply to the international market. $\varepsilon_F^X = -\phi_{RF}\varepsilon_R/k_X$ and $\varepsilon_N^X = -\phi_{RN}\varepsilon_R/k_X$ are the export supply elasticities with respect to the farm price and the price of non-farm inputs, respectively. Both of them are negative, implying that a higher input price reduces the export supply. The effect of the value-added tax on the export supply is indicated by $-k_D\eta_R^D/k_X$, which takes positive values. This means that a higher value-added tax on the retail domestic market increases the export supply.

Then, by equalizing equations (19) and (12) and substituting (14), the retail supply price can be obtained:

$$\begin{aligned} P_R^{S*} = & -\{(k_X \eta_R^X + k_D \eta_R^D)/[k_X(\eta_R^X - \varepsilon_R^X)]\} VAT^* + \\ & +[\eta_R^X/(\eta_R^X - \varepsilon_R^X)] ETR^* + [\varepsilon_F^X/(\eta_R^X - \varepsilon_R^X)] P_F^* + \\ & +[\varepsilon_N^X/(\eta_R^X - \varepsilon_R^X)] P_N^* \end{aligned} \quad (20)$$

[2] According to Enke (1944) and Kinnucan and Zhang (2004), when one takes into account the ability of the government to exercise market power, a country within which there is pure competition amongst buyers and sellers can be treated as a "large economy", which means that when it acts as a collective unit, this country holds monopoly power or monopsony power to influence the world price.

[3] $VAT = 1 + r_V$, where r_V is the rate of value-added tax; $ETR = 1 + r_g$, where r_g is the rate of export tax rebate.

[4] All other exogenous variables that may affect demand and supply are assumed to be constant, and hence are suppressed. P_N (e.g., the price of marketing service) is assumed to be exogenously given to simplify the derivation of the price transmission elasticities (see Appendix A for details).

Table 1: Baseline data and model parameters.

Item	Definition	Value
η_R^D	Retail-level domestic demand elasticity	-0.31, -0.80, -1.40 [a]
ε_R	Retail-level supply elasticity	0.67 [b]
η_R^X	Retail-level export demand elasticity	-0.95 [c]
η_F	Elasticity of demand for farm inputs	-0.27, -0.70, -1.23 [d]
ε_F	Farm-level supply elasticity	0.59 [d]
ϕ_R	Price transmission elasticity from the farm market to the retail market	0.81 [e]
ϕ_{FR}	Price transmission elasticity from the retail market to the farm market	1.26 [e]
k_D	Retail-level domestic quantity share (=D_R/S_R)	0.92 [f]
k_X	Retail-level export quantity share (=X_R/S_R)	0.08 [f]
$P_R^0 S_R^0$	Total revenue of retail-level producers	25,130 [g]
$P_R^0 D_R^0$	Retail-level domestic consumer expenditure	22,640 [g]
$P_R^0 X_R^0$	Foreign consumer expenditure on Chinese fishery products	2,490 [g]
$P_F^0 D_F^0$	Total expenditure on farm-level products	16,780 [g]
$P_F^0 S_F^0$	Total revenue of farm-level producers	16,780 [g]
V_D	Percentage change in the farm price when D_F^* and P_N^* equal zero	0.001 [h]
V_S	Percentage change in the retail price when S_R^* and P_N^* equal zero	0.0004 [h]

[a] Taken from Han et al. (1997), Dey (2008), and Ma (2004), respectively.
[b] Taken from Dey (2008)
[c] Taken from Graham *et al*. (1998)
[d] Computed based on Tewari (2003): as η_R^D changes, η_F varies too
[e] See Appendix A for details
[f] Taken from the Chinese Yearbook of Fishery Statistics (2012) and the United Nations Commodity Trade Statistics Database
[g] Taken from the Chinese Yearbook of Fishery Statistics (2012) and the Report of the Ministry of Agriculture of China. All data include tilapia, crustacean, and molluscs. Unit: million dollars
[h] Computed based on the formulas in Sun and Kinnucan (2000)
Source: own composition

When the linkage between the farm and the retail markets is not considered, the reduced form of the elasticity of supply price with respect to the export tax rebate is represented by $\eta_R^X/(\eta_R^X-\varepsilon_R^X)$, which is restricted to being a positive value, indicating that an export tax rebate on the export products causes the supply price to move up. Hence, the effect of the tax rebate on the supply price is determined by the relative magnitude of the export demand and supply elasticities. When the domestic producers face a perfectly elastic export demand curve or a perfectly inelastic export supply curve, then $\eta_R^X/(\eta_R^X-\varepsilon_R^X)=1$. This means that the export tax rebate is completely passed on to Chinese producers, and thus it has the largest possible effect. In contrast, when China has a perfectly elastic export supply curve or a perfectly inelastic export demand curve, $\eta_R^X/(\eta_R^X-\varepsilon_R^X)=0$, that is, the tax rebate has no impact on domestic producers. As derived above, $\varepsilon_R^X=(\varepsilon_R-k_D\eta_R^D)/k_X$, indicating that a larger retail supply elasticity, domestic demand elasticity or a larger market share of the domestic market increases the export supply elasticity, and thus attenuates the effectiveness of the export rebate. This result is consistent with the study by Ishikawa and Kuroda (2007), which finds that whether or not an export promotion policy improves the welfare of the export country depends on the slope of the inverse demand curve and the market share.

If, instead, the linkage between the farm and retail markets is taken into consideration, the reduced-form supply price is as follows:

$$P_R^{S*}=-\{(k_X\eta_R^X+k_D\eta_R^D)/[k_X(\eta_R^X-\varepsilon_R^X+\xi)]\}VAT^* + \\ +[\eta_R^X/(\eta_R^X-\varepsilon_R^X+\xi)]ETR^* + \\ +\{\varepsilon_N^X/[(\eta_R^X-\varepsilon_R^X)(\eta_R^X-\varepsilon_R^X+\xi)]\}P_N^* \quad (21)$$

where $\xi=(\varepsilon_R^X\phi_{FR}\eta_F)/(\eta_F-\varepsilon_F)>0$, suggesting that after taking into account the farm-retail linkage, the effects of the export tax rebate on Chinese producers' supply price become larger.

When one turns to the effects of this policy on the farm price, the relationship between the farm and the retail supply prices can be obtained by imposing the market clearing condition in the farm market:

$$P_F^*=[(\phi_{FR}\eta_F)/(\eta_F-\varepsilon_F)]P_F^{S*}+ \\ +[(\phi_{FN}\eta_F)/(\eta_F-\varepsilon_F)]P_N^* \quad (22)$$

where the coefficient $[(\phi_{FR}\eta_F)/(\eta_F-\varepsilon_F)]>0$, indicating that the effects of a value-added tax or an export tax rebate on the farm price are in the same direction as the effects on the retail supply price. Therefore, an increase in the value-added tax in the export market depresses the farm price. In other words, the farm price can be increased by an export tax rebate. For the farm price, the effectiveness of the export tax rebate is determined not only by the relative magnitude of the demand and supply elasticities of export and by the market shares, but also by the relative magnitude of the demand and supply elasticities at the farm level and the price transmission elasticity from the retail market to the farm market. A higher price transmission elasticity implies a larger effect of the export rebate on the farm price. Since $0<[\eta_F/(\eta_F-\varepsilon_F)]<1$, $[(\phi_{FR}\eta_F)/(\eta_F-\varepsilon_F)]$ has an upper limit of ϕ_{FR} and a lower limit of 0.

The measure for welfare

According to Alston et al. (1995), in a multi-stage market, the measurement of welfare change is not affected by the choice of the market level to be measured. To avoid double counting, in this paper, we choose the retail market to measure welfare changes in the industry. Following Sun and Kinnucan (2001), by assuming parallel shifts of demand and supply curves, the welfare changes for Chinese domestic producers, domestic consumers, and foreign consumers are approximated by the following formulas:

$$\Delta CS_D = -P_R^0 D_R^0 P_R^{D*}(1 + 0.5D_R^*) \quad (23)$$

$$\Delta PS_D = -P_R^0 S_R^0 (V_S - P_R^{S*})(1 + 0.5S_R^*) \quad (24)$$

$$\Delta CS_X = -P_R^0 X_R^0 P_R^{X*}(1 + 0.5X_R^*) \quad (25)$$

where ΔCS_D is the change in domestic consumer surplus associated with the export tax rebate changes; ΔPS_D is the change in producer surplus at the retail level; ΔCS_X is the change in the foreign consumer surplus due to a change in the export tax rebate. Moreover, $P_R^0 D_R^0$ is the retail-level domestic consumer expenditure in the initial equilibrium; $P_R^0 S_R^0$ is the total revenue of Chinese producers for both domestic and export markets in the initial equilibrium; and $P_R^0 X_R^0$ is the foreign consumer expenditure on Chinese products. P_R^{D*}, P_R^{S*}, and P_R^{X*} are the relative changes in retail-level domestic demand price, supply price, and export price, respectively. Similarly, D_R^*, S_R^*, and X_R^* are the relative changes in retail-level domestic demand, total supply, and exports associated with the changes in the export tax rebate, respectively. Finally, V_S is the percentage change in the retail price when the changes in both quantity and non-farm price equal zero.

As mentioned before, considering a multi-stage market allows us not only to represent a more realistic setting, but also to obtain the producer surplus changes in the farm market as follows:

$$\Delta PS_F = -P_F^0 S_F^0 P_F^*(1 + 0.5S_F^*) \quad (26)$$

where ΔPS_F is the change in farm producer surplus associated with a change in the export tax rebate; $P_F^0 S_F^0$ is the revenue of farm producers in the initial equilibrium; P_F^* is the relative change in the farm price; and S_F^* is the relative change in farm supply. V_D is the percentage change in the farm price when the changes in both quantity and non-farm input price equal zero.

Parameterization

To apply the above model to Chinese fishery sector, we survey the empirical literature to determine or derive the "best-bet" values for the numerical values of the elasticities of demand, supply, and price transmission. These values, combined with other necessary data in Table 1, are then used to simulate the effects of *VAT* and *ETR* on prices, trade flows, and welfare distribution. Among the parameter values, there is a large variation in the value of domestic demand elasticity reported by different studies. Thus, a sensitivity analysis is performed by considering alternative values of this parameter to determine sensitivity, and to highlight the finding that a higher domestic demand elasticity (which implies a higher export supply elasticity) impairs the effectiveness of the export tax rebate policy. Moreover, two scenarios are considered, depending on whether the vertical linkage between farm and retail markets is considered or not (Scenario 1 and Scenario 2, respectively).

Results

Pass-through of the export tax rebate

The incidence of the export tax rebate in the Chinese fishery sector is shown in Table 2. For example, the reduced-form elasticity of the domestic supply price with respect to the export tax rebate indicates the percentage change in the supply price associated with a percentage change in *ETR*. As mentioned before, $\xi > 0$ means that the linkage between farm and retail markets is considered. Since the non-farm price P_N^* is used to derive the parameters, we will not discuss its effects.

Focusing first on the retail market, when $\xi > 0$, a 1% increase in *VAT*[5] is split between a 0.13%-0.55% increase in export price (as well as domestic demand price) and a 0.45%-0.87% decrease in the Chinese supply price. Chinese producers have a heavier burden as the domestic demand elasticity rises. The higher domestic demand price reduces the quantity demanded in the domestic market by about 0.17%-0.21%. The lower supply price reduces the quantity of supply by about 0.17%-0.21%.

When it comes to the effects of the export tax rebate, Table 2 shows that a 1% increase in *ETR* is split between a 0.05%-0.09% increase in the retail supply price and a 0.91%-0.95% decrease in the export price. In other words, the export tax rebate has a much larger effect on reducing the foreign consumers' price than on improving the domestic producers' one. As a result, the quantity of export is increased by 0.86%-0.90%, whereas the quantity of domestic supply is only increased by at most 0.04%.

As the sensitivity analysis suggests, the domestic producers' benefits get smaller when the domestic demand becomes more price elastic, which in turn increases the magnitude of the export supply elasticity. This highlights the fact that the positive effect of the export tax rebate on the supply price depends on the relative magnitude of the export supply and demand elasticities. Specifically, if the export supply elasticity is much larger than the export demand elasticity, an export tax rebate has a small effect on increasing the domestic supply price, but a large one on reducing the export price.

Then, when one focuses on the farm market, an increase in the value-added tax reduces the quantity of supply at the retail level, and thus depresses the price at the farm level and reduces the quantity of farm supply and demand. On the other hand, a 1% increase in *ETR* increases the farm quantity by 0.03% (which is insensitive to the change of η_d), and increases the farm price by 0.04-0.06%. Based on the foregoing results presented in Section 2, the reason for such results is clear: the retail supply is enlarged by an export tax rebate, and thus quantity and price for the farm are also enhanced.

[5] It should be noted that a 1% change in variable *ETR* equals a 1% change in $(1+r_E)$ instead of a 1% change in r_E. Similarly, a 1% change in variable *VAT* equals a 1% change in $(1+r_V)$, instead of a 1% change in r_V.

Table 2: Reduced-form elasticities.

Endogenous Variable	Exogenous Variable					
	VAT^*	ETR^*	VAT^*	ETR^*	VAT^*	ETR^*
$\xi > 0$						
	$\eta_d = -0.31$		$\eta_d = -0.80$		$\eta_d = -1.40$	
D_R^*	-0.17	-0.03	-0.21	-0.06	-0.18	-0.07
S_R^*	-0.20	0.04	-0.21	0.02	-0.17	0.01
X_R^*	-0.53	0.86	-0.25	0.88	-0.12	0.90
P_R^{D*}	0.55	0.09	0.26	0.07	0.13	0.05
P_R^{X*}	0.55	-0.91	0.26	-0.93	0.13	-0.95
P_R^{S*}	-0.45	0.09	-0.74	0.07	-0.87	0.05
D_F^*	-0.12	0.03	-0.35	0.03	-0.51	0.03
S_F^*	-0.12	0.03	-0.35	0.03	-0.51	0.03
P_F^*	-0.21	0.04	-0.59	0.06	-0.87	0.05
$\xi = 0$						
	$\eta_d = -0.31$		$\eta_d = -0.80$		$\eta_d = -1.40$	
D_R^*	-0.20	-0.02	-0.36	-0.04	-0.36	-0.04
S_R^*	-0.23	0.05	-0.37	0.03	-0.37	0.03
X_R^*	-0.62	0.88	-0.43	0.90	-0.43	0.90
P_R^{D*}	0.65	0.07	0.45	0.05	0.45	0.05
P_R^{X*}	0.65	-0.93	0.45	-0.95	0.45	-0.95
P_R^{S*}	-0.35	0.07	-0.55	0.05	-0.55	0.05

Source: own composition

Results of Scenario 2 are also shown in Table 2. The comparison implies that, as indicated before, the change in the domestic supply price will be underestimated if the vertical linkage is not considered. However, the supply quantity will be overestimated; thus, the welfare effects of not considering the farm-retail linkage are ambiguous, a topic which will be discussed in detail in the next subsection.

Distribution of the welfare gains

In order to simulate the distribution of welfare gains caused by the changes in *ETR*, inserting the reduced-form elasticities in Table 2 into equations (23)-(25) yields:

$$\Delta CS_D = -P_R^0 D_R^0 [(P_R^{D*}/ETR^*)ETR^*] [1 + (0.5D_R^*/ETR^*)ETR^*] \quad (27)$$

$$\Delta PS_D = -P_R^0 D_R^0 [V_S - (P_R^{S*}/ETR^*)ETR^*] [1 + (0.5S_R^*/ETR^*)ETR^*] \quad (28)$$

$$\Delta CS_X = -P_R^0 X_R^0 [(P_R^{X*}/ETR^*)ETR^*] [1 + (0.5X_R^*/ETR^*)ETR^*] \quad (29)$$

where P_R^{D*}/ETR^*, P_R^{S*}/ETR^*, P_R^{X*}/ETR^*, D_R^*/ETR^*, S_R^*/ETR^*, and X_R^*/ETR^* are set equal to the corresponding reduced-form elasticities given in Table 2.

The "best-bet" measure of the welfare changes is presented in Table 3. All results are for a 1% increase in *ETR*. The third, fifth, and seventh columns show how an increase in welfare is distributed between Chinese producers and foreign consumers. Generally, under both scenarios, the total welfare gains (*TWG*) range from 32.93-42.61 million dollars, most of which go to foreign consumers (60%-75% of *TWG* under Scenario 1, and 57%-73% under scenario 2). This implies that, as highlighted by some financial commentators and taxpayers, with the "best-bet" parameter values, the export rebate in the Chinese fishery sector is subsidising foreign consumers more than domestic producers.

The value and percentage of the benefits for Chinese producers are enhanced even without considering the farm-retail connection, but such an increment is not sufficient to alter the conclusion that foreign consumers are the major beneficiaries of the export tax rebate policy. The comparison between the two scenarios indicates that if we do not consider the farm market, the simulation results on values and percentage of domestic producer gains would be overestimated, and the loss for Chinese consumers would be underestimated. This sheds light on the importance of considering the farm-retail linkage even when the input markets are not of interest.

The sensitivity analysis shows that the total welfare gains are increasing with the growth of the domestic demand elasticity with respect to price. Under both scenarios, the gains for domestic producers and the loss for domestic consumers are both decreasing when the domestic demand becomes more price elastic (which makes the export supply become more elastic as well). This is consistent with the last section, in which we conclude that as the export supply elasticity of an industry rises, *ceteris paribus*, we expect the effects of the export tax rebate on domestic producers to decline. Therefore, reducing the export supply elasticity (e.g., by improving the reliance on imports to reduce the domestic demand elasticity) may be helpful to enhance the effectiveness of the export rebate.

Dividing the welfare measurements of Scenario 1 in Table 3 by 25.11 million dollars (the government spend-

Table 3: Welfare distribution at the retail level (million dollars).

Item	Welfare Changes	Share of Gains	Welfare Changes	Share of Gains	Welfare Changes	Share of Gains
$\xi > 0$	$\eta_d = -0.31$		$\eta_d = -0.80$		$\eta_d = -1.40$	
ΔPS_D	15.75	40%	11.58	32%	8.17	25%
ΔCS_X	23.53	60%	24.21	68%	24.76	75%
ΔCS_D	-15.74	-	-11.58	-	-8.17	-
TWG	39.28	1.00	35.79	1.00	32.93	1.00
$\xi = 0$	$\eta_d = -0.31$		$\eta_d = -0.80$		$\eta_d = -1.40$	
ΔPS_D	18.53	43%	12.89	34%	9.39	27%
ΔCS_X	24.08	57%	24.69	66%	25.07	73%
ΔCS_D	-12.37	-	-8.60	-	-6.27	-
TWG	42.61	1.00	37.58	1.00	34.46	1.00

Note: TWG represents total welfare gains, $TWG = \Delta PS_D + \Delta CS_X$
share of gains $= \Delta PS_D (or\ \Delta CS_X) / TWG$
Source: own composition

ing corresponding to a 1% increase in the export tax rebate) yields the marginal benefit-cost ratios (MBCRs) shown in Table 4.

Table 4: Marginal benefit-cost ratios for a 1% increase in *ETR* in the Chinese fishery sector.

η_d	$MBCR_1$	$MBCR_2$	$MBCR_3$
-0.31	1.56	0.63	Approximately 0
-0.80	1.43	0.46	Approximately 0
-1.40	1.31	0.33	Approximately 0

Note: $MBCR_1 = TWG/25.11$; $MBCR_2 = \Delta PS_D/25.11$; $MBCR_3 = (\Delta PS_D + \Delta CS_D)/25.11$.
Source: own composition

The results for $MBCR_1$ suggest that the total welfare gains overweigh the government expenditure if TWG is con-sidered as comprising the overall "benefits" of this policy. $MBCR_1$ increases with a reduction in η_d. However, as discussed, the total welfare gains are shared between domestic producers and foreign consumers, and with the "best-bet" elasticities, the latter obtain most of the benefits. Only in the extreme cases where the export demand elasticity approaches 1 or the export supply elasticity approaches 0 can the entire export tax rebate be passed on to Chinese producers. Therefore, the results for $MBCR_2$ are of more interest to us. When the domestic demand elasticity is between -0.31 to -1.40, $MBCR_2$ ranges from 0.33 to 0.63. We also compute $MBCR_3$, which takes the Chinese consumer surplus into account, as Kinnucan and Cai (2011) state that, when analysing the effectiveness of a trade promotion policy, the so called "societal MBCRs" should not be ignored, for they indicate the effectiveness from a societal perspective, instead of an industry one. The results imply that when $MBCR_1$ equals 1.31-1.56, $MBCR_3$ approximates 0, due to the fact that the benefits for domestic producers are almost completely offset by the loss for domestic consumers. This is in line with previous studies (e.g., Alston et al., 1993; Wohlgenant, 1986), which find that with the assumptions of no distortion in other sectors and the opportunity cost of government spending equals the amount of payment, such export promotion policies are a costly way to improve domestic producers' welfare.

According to Alston and James (2002), the changes in retail-level producer surplus equal the sum of changes in the producer surplus for all inputs. Thus, considering the farm-retail linkage enables us to obtain the distribution of the welfare gains for Chinese producers between farm and non-farm input producers. To this end, we rewrite equation (26) as follows, and then calculate the welfare changes of both inputs with equation (30) and the results for ΔPS_D in Table 3. The results are presented in Table 5.

$$\Delta PS_F = P_F^0 S_F^0 [(P_F^* / ETR^*) ETR^*] [1 + (0.5 S_F^* / ETR^*) ETR^*] \tag{30}$$

where P_F^* / ETR^* and S_F^* / ETR^* are set equal to the corresponding reduced-form elasticities given in Table 2.

Table 5 indicates that the welfare distribution between producers of farm and non-farm inputs is very sensitive to the variation of η_d. Farmers' share of the welfare gains improves dramatically with the increase in China's domestic demand elasticity in the fishery sector. As the domestic demand becomes more price elastic, farmers gradually become the biggest winners at the input markets. When η_d ranges from -0.31 to -1.40, farmers obtain 7.32 to 9.26 million dollars, accounting for 46% to 99% of the total producer surplus.

Table 5: Welfare distribution at input level (million dollars).

Item	Welfare Changes	Share of Gains	Welfare Changes	Share of Gains	Welfare Changes	Share of Gains
	$\eta_d = -0.31$		$\eta_d = -0.80$		$\eta_d = -1.40$	
ΔPS_F	7.32	46%	9.26	80%	8.12	99%
ΔPS_N	8.43	54%	2.32	20%	0.05	1%
ΔPS_D	15.75	1.00	11.58	1.00	8.17	1.00

Note: *share of gains* $= \Delta PS_F$ (or ΔPS_N) $/\Delta PS_D$
Source: Own composition

Discussion and conclusion

The basic premise of this study is that when considering an export tax rebate, the policymakers should not be indifferent about the benefit distribution among groups. This paper finds that the effectiveness of the export tax rebate on domestic producers depends on the relative magnitude of the export supply and demand elasticities. When the export country has a relatively large export supply elasticity, the benefits of domestic producers are very limited. Applying the model to the Chinese fishery sector, we find that with the "best-bet" parameters, although the total welfare gains overweigh the cost for the government, most of the gains go to foreign consumers. When considering the welfare changes of Chinese consumers, according to Gardner's (1983) criterion[6], the export tax rebate is efficient (under Scenario 1, *dPS/dCS* approaches 1.00). Nevertheless, from a societal perspective, the marginal benefit-cost ratio is almost zero.

Our results are consistent with the previous literature in that when considering an export promotion policy which redistributes welfare among producers, consumers and taxpayers, the policy makers have to assign weightings among these groups (Wohlgenant, 1986). Moreover, this paper emphasizes the importance of considering the transfer from domestic consumers and taxpayers to foreign consumers. Our derivation indicates that the export supply elasticity is determined by the elasticities of supply and domestic demand, and by the relevant market share. Therefore, in an industry with a relatively large domestic market share, a large domestic demand elasticity, or a large retail supply elasticity, the policymakers should be more prudent when considering such policies.

Another policy implication of this paper is that when evaluating a trade promotion policy in an agricultural sector, it is of great importance to take into account the benefits allocation among input producers, which has hardly received attention in the literature. In an industry with a relatively higher domestic demand elasticity, it is expected to have a larger effect on farm producers.

Under the World Trade Organization (WTO) rules, the export tax rebate is not considered as a subsidy as long as the tax rebate does not outweigh the tax paid by companies. The aim is to let the exports enter the international markets at tax-excluded prices and thus avoid double taxation on exports. The reduced-form elasticities indicate that the value-added tax raises the export price and lowers the quantity of exports. Hence without the rebate (or with an incomplete rebate), the value-added tax acts as an export tax (Feldstein and Krugman, 1990). Therefore, if the WTO requires its members to phase out export taxes, an export tax rebate system may be utilised as an export tax to realise export control.

Finally, it should be stressed that the model is based on the assumption that the price of non-farm inputs is exogenous. However, this may not be the case in reality. Hence the relaxation of this assumption provides a topic for further research to extend the present analysis. Moreover, the simulation results are based on elasticity values taken from previous studies, some of which are becoming dated. As the market structure may have changed dramatically, econometric efforts are needed to obtain updated estimations of the price elasticities of demand and supply.

[6] Gardner (1983) states that, when *dPS/dCS* approaches 1.00, the deadweight loss per dollar of consumers' welfare transferred to producers is zero at the margin, thus the policy designed to benefit producers is considered efficient.

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Appendix A. Derivation of price transmission elasticities

In a two-input, one-output demand and supply system, the output supply and the input demand functions are given by:

$$S_R = S_R(P_R^S, P_F, P_N) \tag{A.1}$$

$$D_F = D_F(P_R^S, P_F, P_N) \tag{A.2}$$

$$D_N = D_N(P_R^S, P_F, P_N) \tag{A.3}$$

By taking the logarithmic total differential of the first two equations we get:

$$dlnS_R = \varepsilon_R dlnP_R^S + \varepsilon_{RF} dlnP_F + \varepsilon_{RN} dlnP_N \tag{A.4}$$

and

$$dlnD_F = \eta_{FR} dlnP_R^S + \eta_F dlnP_F + \eta_{FN} dlnP_N \tag{A.5}$$

Thus, we get equations as follows:

$$\phi_{RF} = \partial lnP_R^S / \partial lnP_F = |\varepsilon_{RF}| / \varepsilon_R \tag{A.6}$$

and

$$\phi_{FR} = \partial lnP_F / \partial lnP_R^S = \eta_{FR} / |\eta_F|, \tag{A.7}$$

where ε_{RF} and η_{FR} are the elasticity of retail supply with respect to the farm price and the elasticity of farm demand with respect to the retail price, respectively. To obtain the values of ε_{RF} and η_{FR}, the above demand and supply system can be written as:

$$S_R^* = \varepsilon_R P_R^{S*} + \varepsilon_{RF} P_F^* + \varepsilon_{RN} P_N^* \tag{A.8}$$

$$D_F^* = \eta_{FR} P_R^{S*} + \eta_F P_F^* + \eta_{FN} P_N^* \tag{A.9}$$

$$D_N^* = \eta_{NR} P_R^{S*} + \eta_{NF} P_F^* + \eta_N P_N^* \tag{A.10}$$

With the restrictions of homogeneity and symmetry:

$$\varepsilon_R + \varepsilon_{RF} + \varepsilon_{RN} = 0 \tag{A.11}$$

$$\eta_{FR} + \eta_F + \eta_{FN} = 0 \tag{A.12}$$

$$\eta_{NR} + \eta_{NF} + \eta_N = 0 \tag{A.13}$$

$$\varepsilon_{RF} / \eta_{FR} = - P_F F / P_R R \tag{A.14}$$

$$\varepsilon_{RN} / \eta_{NR} = - P_N N / P_R R \tag{A.15}$$

$$\eta_{FN} / \eta_{NF} = P_N N / P_F F \tag{A.16}$$

Together with the values of ε_R, η_F, and η_N, the values of ε_{RF} and η_{FR} can be obtained.

Kevin MEYER*

The Impact of Agricultural Land Use Change on Lake Water Quality: Evidence from Iowa

The environmental impacts of agricultural policies must be quantified to perform full cost-benefit analyses and make informed policy decisions. In this paper I use a unique panel data set to estimate the effect of changes in cropland on lake water quality. Fifteen years of water quality measurements across over 100 lakes are combined with satellite imagery and weather data. Using a dynamic panel data model, I find that the elasticity of water quality to cropland is 0.0535. To understand the policy implications, I estimate a second model to find the elasticity of cropland to crop prices. I combine these estimates to analyze the effect of the Renewable Fuel Standard (RFS). I find that the RFS decreased lake water quality; however, the magnitude of this effect is negligible.[1]

Keywords: Agriculture, land use, water quality

JEL classifications: Q15, Q18

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Introduction

Understanding the effect of land use on water quality is an important question in environmental policy. Agriculture is consistently identified by the EPA as a cause of water quality degradation due to fertilizer runoff entering nearby waterways (EPA, 2002). These effects have important economic and ecological consequences, such as adverse effects on recreation and drinking water quality. As has been known since the time of Pigou, these effects are a classic case of a market failure (Pigou, 1920). Since water quality is not a market good, the free market will not result in an optimal level of lake water quality. Efficient government intervention requires understanding the benefits and costs of land use on water quality, however measuring these effects has been difficult, primarily due to a lack of suitable data.

The primary research objective of this paper is to estimate the elasticity of lake water quality to land use change. These estimates can be used by future researchers and policymakers as part of cost benefit analyses, where policies affect land use change near lakes. My approach combines high quality water measurements across 100 Iowa Lakes over 15 years, along with satellite data on cropland use and PRISM data on weather. As an extension, I estimated a secondary model of the elasticity of land use change to crop prices. I use the estimates from these two models to estimate the effect of the Renewable Fuel Standard (RFS) on lake water quality. Due to the inelastic estimates from both models, I find a negligibly positive impact of the RFS on lake water quality.

This paper contributes to the literature in several ways. First, it exploits 15 years of water quality measurements across Iowa to perform a statistical analysis of the effect of land use on water quality. Second, it provides strong statistical evidence of a persistent effect of water quality across time. Third, it adds to the literature on the response of cropland expansion to crop prices. Finally, it adds to the literature on the environmental effects of biofuel related policies.

The paper is organized as follows. The next section provides some background on the typical techniques used to assess the relationship between land use and water quality. This is followed by a description of the econometric model used in both the water quality and cropland response models. I then give a detailed description of the data set, followed by the results for both models. These results are then used in an application to estimate the effect of the RFS on lake water quality, followed by a summary.

Background

There is a long history of studies that attempt to identify the relationship between land use and the water quality of lakes, rivers, and streams. Most of these studies can be divided into two types- simulation models such as SWAT and BASINS[2], and econometric models. The former are able to model complex relationships between the climate, land use, and water quality to examine issues that might otherwise be intractable. For example, simulations from these types of programs have been used to examine the hypoxia "dead zone" in the Gulf of Mexico (Rabotyagov, 2014), the effect of corn-based ethanol on environmental quality (Secchi, 2009), and the potential for cropland to reduce flood risk (Schilling, 2014). Simulation models are invaluable for gaining insight into issues that may otherwise be too complicated for any one statistical model to capture, but they have drawbacks. On a practical level, the complexity of the simulated relationships requires many parameters, and choosing these parameters requires a significant amount of expertise. This can make it difficult for other researchers to truly understand what is generating the results. Statistical models, on the other hand, are helpful in their ability to model relationships between variables in a relatively straightforward and transparent way.

Many statistical analyses in the literature rely on simple correlation coefficients between different land uses and a

[1] I would like to thank the EPA for their support of related work as a graduate student at Iowa State University. In addition, thanks to David Keiser, Catherine L. Kling, Gian Carlo Moschini, Quinn Weninger, and John Beghin for their helpful comments.

[2] SWAT stand for Soil and Water Assessment Tool; BASINS stands for Better Assessment Science Integrating point & Non-point Sources.

measure of water quality. For example, Tong (2002) found a statistically significant positive correlation of 0.1913 and 0.1563 between agriculture and total nitrogen and phosphorous in surface water, respectively, in 11-digit HUCS in Ohio. In fact, most studies find a positive correlation between the two variables (Meador, 2003; Dauer, 2000). While correlations are informative, they do not help isolate causal effects. In other words, the question arises: does an increase in cropland cause the water quality to drop, or could it represent something else, such as the quality of the land? Answering this requires a model that controls for the quality of land, as well as other possible omitted variables.

Many studies have used regression techniques to try to estimate the relationship. Tu (2011) uses geographically weighted regressions to estimate local effects in an area surrounding Boston. He estimates a separate univariate regression for 6 different water quality variables and 14 land uses, for a total of 84 regressions. The results showed little influence of agricultural land on water quality. A drawback of this study is that water quality measurements are averaged over time and estimated using only one year of observed land uses. In fact, cross-sectional regressions are common in water quality studies – possibly due to a lack of quality, publicly available time series data. Another technique used in the literature is to use simple univariate regressions of land use on water quality (see, e.g. Lougheed, 2001). Limiting the model to one period, or not controlling for other factors that can affect water quality can potentially bias the coefficients of interest.

This omitted variable bias problem can potentially create misleading results. For example, Sprague (2012) studies the effect of the Conservation Reserve Program (CRP) on total nitrogen and phosphorus loadings in rivers using a cross-sectional regression and found a marginally positive effect, indicating that CRP land increases nutrient levels; this is the opposite effect intended by the program and lacks a credible explanation. The key problem in this study is that, for the results to hold, the model must assume that CRP land is randomly distributed across space and uncorrelated with omitted factors that affect water quality. This is unlikely to be the case since profit maximizing landowners will choose to retire the least profitable farmland into the CRP first. In Iowa, for example, CRP land is concentrated in the south, where the soil quality is relatively low. Therefore, it would not be surprising to find a negative correlation between CRP land and water quality, since lower quality soil typically means increased runoff.

The geographic characteristics of water bodies has led to some studies that use more complicated regression models. Atasoy (2006) employs spatial econometric techniques to study the effect of urban land use on water quality. Their analysis uses monthly nutrient measurements over a four-year period combined with monthly measures of urban development, weather variables, and a single year of satellite imagery to control for agricultural land. Their emphasis on rivers and streams is an example of how geography plays an important role in the specification of an appropriate econometric model when studying environmental issues. In their study, upstream river quality clearly affects downstream river quality as it is carried through a stream network, thus it makes sense to explicitly include a spatially-lagged dependent variable while allowing for temporal correlations in the error term. In this study, where the observed unit is lakes, it does not make sense conceptually to include a spatial lag, since lakes do not flow into each other. Instead, it is appropriate to include a temporal lag of the dependent variable, since lake water remains relatively stationary over time. This implies that nutrient levels may persist; this effect is known as the "hydraulic retention time". As an example, Jeppesen (2005) reduced the nutrient levels in multiple lakes and observed that the lakes did not reach a new, lower steady state for 15 years.

Existing lake water quality studies that attempt to include dynamics have typically been confined to one lake and its watershed. For example, Balkcom (2003) use multiple samples from a lake over time to calibrate an integrated assessment model, which was then used to analyse different land use scenarios. By contrast, this study uses data on over 120 lakes over 15 years, creating a rich variation in lake quality, geographical characteristics, and the characteristics of surrounding land use.

As one of the most productive farming states in the country, Iowa land use can be particularly sensitive to changes in farming policies. Therefore, given the evidence of the link between cropland and water quality degradation, government policies can directly and indirectly affect water quality. Two primary examples are the Conservation Reserve Program (CRP), and the Renewable Fuel Standard (RFS). The CRP has evolved from its initial goals of removing cropland from production to focus more on maximizing the environmental impact of the program. Only land currently in production or expiring CRP land are eligible to be retired and receive CRP subsidies, and retired land must be planted with species that will improve environmental health and quality. Thus, the possible water quality benefits of an acre of CRP land are 1) removing a hectare of cropland, and therefore all related nutrient use, and 2) replacing it with a hectare plants that can help improve soil quality and reduce runoff of nutrients from the surrounding area. CRP land in Iowa began a major decline around 2007. It is likely that multiple factors contributed to this decline, especially rising crop prices (and thus profitability of land) and a decline in funding for the program.

The RFS, first established under the Energy Policy Act of 2005, mandated 28 billion liters of ethanol be used by 2012. The scope of the biofuel mandate expanded significantly in 2007 by mandating 136 billion liters of ethanol in the U.S. by 2022. Most of the current biofuel supply comes from corn ethanol. Therefore, the biofuel mandate has and will continue to have significant economic and environmental impacts on Iowa, the nation's leading corn producer. Researchers have identified water quality degradation as an important consequence of biofuel production (Simpson, 2008). Although corn cultivation requires a significant amount of water, water shortages are typically not a concern in Iowa. Rather, the increased use of nutrients from expanding corn production along both the intensive and extensive margin are of concern. In addition, an increase in the demand for corn can affect the price of other crops, such as soybeans, which can cause cropland expansion for those crops as well. As corn uses nitrogen relatively inefficiently (Balkcom, 2003), switching over to

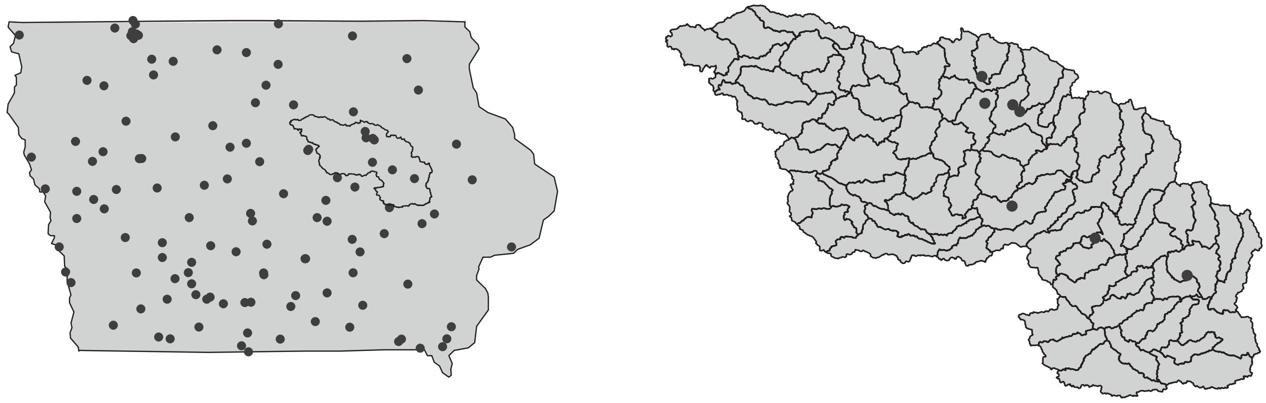

Figure 1: Location of Iowa lakes, represented by solid dots (left), a HUC 8 watershed comprised of smaller HUC12 watersheds (right).

Source: Iowa State Limnology Department, retrieved from http://limnology.eeob.iastate.edu/lakereport/default.aspx

corn from other crops can potentially increase the amount of nitrogen in the soil. Finally, if we assume that farmers grow crops on the best farmland available, cropland expansion will likely occur in marginal, more environmentally sensitive areas, including CRP land (Secchi, 2009). Thus, the two policies mentioned here are to some degree interdependent, as farmer's will look to maximize their profit by either accepting subsidies to retire the land into the CRP, or to farm the land and sell their crops.

Data

Water quality data were downloaded from Iowa State's Limnology Laboratory website [3]. The Iowa Lakes data uses consistent, scientifically based, and well documented hydrological sampling methods. In this paper I use the average of three annual measurements. Averaging three lake water samples over a year offers adequate precision for water quality indicators (Downing, 2006). CTSI, a measure of lake water clarity, is used as the main water quality indicator because it summarizes the outcome of increased sediment or nutrient loadings, as opposed to a measurement of the inputs of sediments or nutrients into a lake. Most lakes have a CTSI between 0-100, with each increase of 10 units representing an approximate doubling in algal biomass. An intuitive way to think about the index is that a CTSI of 0 represents a visible depth of 64 meters, while a CTSI of 100 represents a visible depth of only 6.4 centimeters. The CTSI can be approximately divided into four trophic classes: oligotrophic (less than 30-40), mesotrophic (40-50), eutrophic (50-70), and hypereutrophic (70-100+). The left panel of Figure 1 shows the locations of the 123 lakes used in this study.

Annual land use data comes from USDA NASS cropland data layers (CDL's), which are satellite images. Each pixel of a satellite image is assigned a land use based on color analysis. I find the total land use for a geographic region by summing the pixels assigned to each land use. Since the focus of the paper is water quality, land use was aggregated to the local watershed level, known as a HUC (hydrologic unit code). Aggregating to a watershed captures drainage characteristics more accurately than aggregating to an arbitrary governmental boundary. HUC's differ in size and are nested within each other- a HUC12 is located within a HUC10, which itself is within a HUC8, and so on. The right panel of Figure 1 shows the size of typical HUC12 watersheds, as well as the larger HUC8 which contains them.

For this paper I focus on land devoted to corn, soybeans, and grassland[4]. An issue with using cropland devoted to corn and soybean use is they are strongly positively correlated, with a correlation coefficient of .80. To avoid multicollinearity, I sum these two land uses into a single variable labeled *crops*. Since official CRP enrollment numbers are only available at the county level, I include grassland as a proxy for the effect of CRP land on water quality.

Data for precipitation and temperature were calculated from Oregon State's PRISM dataset[5]. PRISM provides the daily precipitation and temperature for 30km by 30km grid cells that cover the continental U.S. To find the annual precipitation for an individual HUC12 I sum the daily data for each PRISM grid cell across the watershed, and then sum the daily values over the year. To find the average annual temperature for each HUC12 I average daily temperatures across PRISM grid cells, and then average the daily values over the year.

Table 1 provides a description and summary statistics for the variables included in the analysis.

Empirical Models

Water Quality Model

I use the following dynamic panel data model to estimate the effects of land use on water quality:

$$Q_{\{i,j,t\}} = \mu_i + B_1 Q_{\{i,t-1\}} + B_2 C_{\{j,t\}} + B_3 G_{\{j,t\}} + B_4 W_{\{j,t\}} + \\ + B_5 T_{\{j,t\}} + \lambda_t + \varepsilon_{\{i,t\}} \quad (1)$$

The dependent variable, $Q_{\{i,j,t\}}$ is a measure of water quality for lake *i* in HUC12 *j* at time *t*. For the measure of water quality, I use Carlson's Trophic State Index (CTSI). CTSI is

3 http://limnology.eeob.iastate.edu/lakereport/default.aspx

4 Although CDL data includes other crops such as wheat, they are more difficult to accurately identify. Data on CDL accuracy can be found at http://www.nass.usda.gov/research/Cropland/sarsfaqs2.htm

5 Downloaded from http://prism.oregonstate.edu

an index of water quality from 0 to 100, where an increase indicates a degradation in water quality (Table 1).

Table 1: Summary statistics of the variables.

	mean	sd	10th percentile	90th percentile
water quality model:				
CTSI	60.81	9.89	47.00	73.00
Crops	5.17	2.89	2.05	8.98
Grass	2.26	1.51	0.63	4.26
Precipitation	39.26	16.60	21.21	58.96
Temperature	9.57	2.37	6.48	12.95
cropland model:				
Crops	5.41	2.99	1.74	9.61
Expected Price	1.70	0.55	1.00	2.51
Fertilizer	71.97	26.25	37.40	101.40
Fuel	68.73	23.45	33.40	99.30
Precipitation	38.77	16.33	22.20	55.75
Temperature	9.59	2.25	6.71	12.64
N	27,472			

Notes: The unit of observation for both models is a HUC12 watershed. The water quality model contains data from 2001-2016 for 123 Iowa lakes, with some gaps. CTSI stands for Carlson's Trophic State Index, a measure of water quality. The cropland model contains annual data from 2001-2016 for all 1717 HUC12 watersheds in Iowa. The sources for "Crops", "Precipitation", and "Temperature" are the same for both the water quality model and the cropland model.
Source: own estimations based on USDA and PRISM data

I include the lag in Q to account for the stock effects of lake water; the coefficient is expected to be positive as a certain amount of nutrients in a lake carry over across years. Including a lag of Q implies both short and long-term impacts from the other right-hand side variables on water quality. The short term, i.e. contemporaneous impacts are the estimated coefficients on the variables, while the long-term impacts are these coefficients multiplied by the dynamic multiplier (Greene, 2000):

$$\sigma = \frac{1}{(1-B_1)} \quad (2)$$

The variables C and G represent year t, HUC12 j's hectares of cropland and grassland, respectively. The main coefficient of interest is , which measures the short-term marginal change in water quality due to an increase in cropland. Since an increase in CTSI represents lower water quality, is expected to be positive due to nutrient runoff. Of secondary interest is the marginal increase in water quality due to an increase in grassland, , which could be considered a proxy to the effect of CRP on water quality. A negative sign on would indicate beneficial qualities of increased grassland near lake water. Since the CRP program requires active cropland to be retired, the total short-term effect of CRP on lake water quality is $(-B_2 + B_3)$.

I control for the effect of weather on water quality by including annual measures of precipitation, W, and temperature T. Although the focus of the paper is on the effect of crops on water quality, the effect of weather on water quality is an important and complicated topic. For example, it is not clear a priori what the sign of these weather effects will be; increased rainfall, for example, can dilute existing nutrient levels, but can also increase nutrient runoff from nearby farms. Several papers have also highlighted the importance of studying the effects of weather on water quality, given the predicted increased variation in weather due to climate change (Delpla, 2009). The coefficient estimates on precipitation and temperature help shed light on these issues.

I control for time invariant, unobservable variables through lake level fixed effects, thus the coefficients are identified by the variation of the data within a lake. The unobservable variables could be, for example, geographic features that are fixed over time, such as soil quality, slope, or surface area, and it can also include permanent man-made structures that can alter the flow of water to lakes, such as tile drains. Year dummy variables control for unobserved trends over time.

Each HUC12 watershed is contained within larger watersheds which share drainage properties. To control for correlation between HUC12's within the same drainage area, I cluster standard errors at the HUC8 level.

Cropland Response Model

To estimate the response of cropland to crop prices I estimate the following Nerlovian partial adjustment model (Nerlove, 1956):

$$C_{\{j,t\}} = \eta_j + B_1 C_{\{j,t-1\}} + B_2 E[P_{\{j,t\}}] + B_3 T_{\{j,t-1\}} + B_4 W_{\{j,t-1\}} + \\ + B_5 F_{\{t-1\}} + B_6 G_{\{t-1\}} + B_7 t + \varepsilon_{\{j,t\}} \quad (3)$$

This model assumes that a representative farmer in watershed j make spring acreage decisions based on last year's acreage, climate and operating costs, as well as the expected crop prices during fall harvest. Operating costs consist of fertilizer, F, and fuel, G.

The variable of interest is which represents the marginal change in cropland due to an increase in expected prices. For the expected price I construct a Laspeyres price index using futures prices on corn and soybeans, along with observed soybean and corn acreages (Huang, 2010; Evans, 2015):

$$E[p_{\{j,t\}}] = \frac{\Sigma_c \left(E[P_{\{j,c,t\}} C_{\{j,c,t_0\}}]\right)}{\Sigma_c \left(E[P_{\{j,c,t_0\}} C_{\{j,c,t_0\}}]\right)} \quad (4)$$

where c is either corn or soybeans. Figure 2 shows the crop price index in Iowa from 2001-2016, averaged over HUC12 watersheds.

Estimation

Dynamic panel data models with fixed effects suffer from the well-known "Nickell bias", which results from the *within* transformation that subtracts the time mean from each group in order to remove the fixed-effects (Nickell, 1981). In a dynamic model, this will cause the lagged, transformed dependent variable to be correlated with the error term, violating the assumed orthogonality condition. One solution is to use the Arellano-Bond model (henceforth abbreviated as

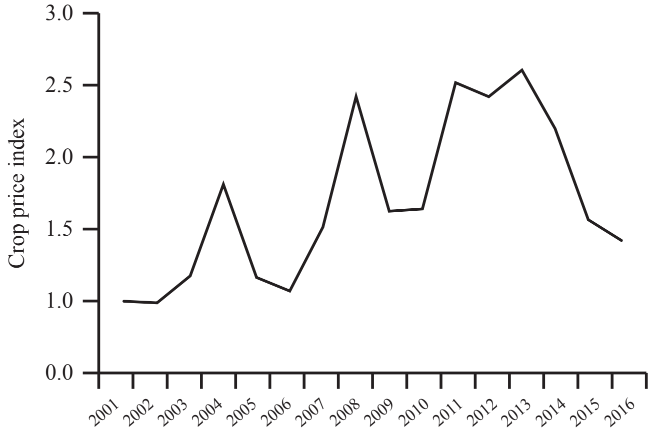

Figure 2: Crop Price Index for corn and soybeans in Iowa, averaged over HUC 12 watersheds from 2001-2016.

Note: Crop Price Index is a Laspeyres' Index using futures prices for corn and soybean along with corn and soybean acreage.
Source: Chicago Board of trade, retrieved from https://www.quandl.com/data/CHRIS-Wiki-Continuous-Futures

Table 2: Regression Results: Water Quality Model

	AB	OLS	FE
L.CTSI	0.2600***	0.7430***	0.3000*
	(0.0410)	(0.0261)	(0.0529)
Crops	0.0538***	0.0076*	0.0251
	(0.0179)	(0.0044)	(0.0252)
Grass	0.0032	-0.0085	-0.0044
	(0.0083)	(0.0053)	(0.0092)
Prec.	0.0460***	0.0312***	0.0406*
	(0.0139)	(0.0093)	(0.0201)
Temp.	0.0324	0.0307*	0.0185
	(0.0261)	(0.0157)	(0.0304)
N	1,484	1,607	1,607

Notes: Arellano-Bond (AB), OLS, and fixed effects (FE) coefficient estimates and standard errors. Each observation is a water quality measurement from a specific lake in Iowa. Data include the years 2001-2016, excluding 2008. All estimates include year fixed effects. CTSI stands for Carlson Trophic Secchi Index. Crops is equal to the sum of corn and soybean land. Standard errors are clustered by HUC8 watershed. *** stands for 1% of significance, ** for 5% and * for 10%
Source: own estimations based on USDA and PRISM data

AB), also known as the "difference GMM" (Arellano, 1991), which constructs instruments for the lagged dependent variable using transformations of the data.

The model's nickname comes from using first differences of the data to remove fixed effects. However, when there are gaps in the data, as is the case with the CTSI measurements, they can result in a significant loss of observations. For example, all lakes in the data set are missing the year 2008, so neither $\Delta Q_{\{i,2008\}}$, or $\Delta Q_{\{i,2009\}}$ can be included in the estimation. Instead of the first difference transformation, I employ the forward orthogonal deviations (FOD) transformation, where the mean of all future observations of a variable is subtracted from the current observation for each year. This purges the fixed effects and allows for more observations than the first differences in an unbalanced panel.

AB estimates are typically estimated in both one and two-step variants. The two-step model uses a weighting matrix that is the inverse of an estimate of Var(z'e), where *z* is the vector of instruments. This is the optimal weighting matrix in the sense that it is asymptotically efficient. However, in finite samples the two-step estimates have been shown to be biased downward. To fix this, I employ the finite sample bias correction described in (Windmeijer, 2005).

Results

Table 2 displays the results for the water quality model. All variables are estimated in log form, so the coefficients are interpreted as the elasticity of water quality with respect to each variable. Column (1) shows the estimated coefficients using the Arellano-Bond model, which instruments for the endogenous lagged dependent variable.

The coefficient on the lag of CTSI is statistically significant and positive, which provides evidence that water quality conditions persist over time. The coefficient on *Crops* is positive and statistically significant, indicating that an increase in cropland increases CTSI and therefore lowers water quality. This result is intuitive since an increase in cropland implies increased nutrients on the land, which can drain into neighboring water bodies. The elasticity for the *Crops* coefficient is 0.0538 in the short run and, using equation (1), 0.0727 in the long run. I do not find a statistically significant effect of grassland on lake water quality.

The coefficient on precipitation is positive and statistically significant. This indicates that the overall effect of precipitation on water quality is detrimental. In other words, the effect of runoff due to precipitation dominates the dilution effect of increased precipitation in lakes. I do not find evidence of an effect of temperature on lake water quality.

Columns (2) and (3) of table 2 display the results of OLS and fixed effects (FE) estimation for comparison. The OLS estimates may suffer from omitted variable bias since it does not control for time invariant fixed effects. The coefficient on the lag of *CTSI* is positive and statistically significant, and over twice as large in magnitude as the Arellano-Bond estimate. This positive bias is a direct result of the omitted variable bias, as shown in (Roodman, 2009). The coefficient on *Crops* is positive and statistically significant. The magnitude of the coefficient indicates that a 1% increase in cropland is associated with a 0.08% increase in CTSI (and therefore water quality is worse). This estimate is slightly higher than the

Arellano-Bond model. As with the Arellano-Bond model, the effect of precipitation is positive and significant, indicating that an increase in precipitation increases CTSI.

The fixed effects model, which does not instrument for the endogenous lagged variable, finds a positive and statistically significant coefficient on the lag of water quality. The magnitude of the coefficient, at 0.300, is like the Arellano-Bond model. The coefficients on *Crops* and *Grass* are not statistically significant. The coefficient on precipitation is positive and marginally significant, although the magnitude is like the other two models.

Table 3 displays the results for the cropland response model. Again, the variables are logged so that the estimates can be interpreted as the elasticity of cropland to a specific variable. All variables show a statistically significant effect on cropland. The variable of interest, price, shows the expected positive relationship with cropland. The magnitude of the elasticity of cropland to prices, 0.066, is small but comparable to other estimates from the literature (Barr, 2011; Evans, 2015). Using the dynamic multiplier, the long run elasticity is 0.104.

Table 3: Regression Results: Cropland Response Model.

	AB	OLS	FE
L.Crops	0.3040**	0.9510**	0.6700**
	(0.0798)	(0.0070)	(0.0278)
Price	0.0525**	0.0466*	0.0479*
	(0.0158)	(0.0222)	(0.0200)
L.lnPrec	0.0017	0.0235**	0.0160
	(0.0139)	(0.0084)	(0.0127)
L.lnTemp	-0.1670**	-0.0306**	-0.0798**
	(0.0263)	(0.0089)	(0.0151)
L.Fuel	-0.1060**	-0.1060**	-0.1010**
	(0.0224)	(0.0290)	(0.0273)
L.Fert	0.0446**	0.0828**	0.0684**
	(0.0112)	(0.0186)	(0.0147)
N	24,033	25,750	25,750

Notes: Arellano-Bond (AB), OLS, and fixed effects (FE) coefficient estimates and standard errors. Each observation is a HUC12 watershed in Iowa. Data include the years 2001-2016. Crops is equal to the sum of corn and soybean land. Standard errors are clustered by HUC8 watershed. ** stands for 1% of significance, * for 5%.
Source: own estimations based on USDA and PRISM data

The results for the control variables are mostly intuitive. The weather variable coefficients indicate that cropland decreases in response to increases in the previous year's temperature, while it increases in response to the previous year's precipitation. The magnitude of these responses is small and roughly equal. Increases in last year's fuel costs have a negative effect on this year's cropland. On the other hand, increases in the cost of last year's fertilizer have a positive effect on this year's cropland. Although this result is not intuitive, it has been found in other research (Evans, 2015; Huang, 2010).

Columns (2) and (3) show the OLS and fixed effects results of the cropland response model. The signs and magnitudes of the coefficients are similar across all three models, except for the coefficient on the lag of crops, where the FE and OLS estimates are larger than the Arellano-Bond estimate.

Application to the Renewable Fuel Standard

This section uses the previous elasticity estimates to measure the impact of the Renewable Fuel Standard (RFS) on lake water quality in Iowa. Since the RFS was enacted in 2005, I focus on the effects over 2006 to 2016, which is the most recent year with available data. The RFS mandated a large increase in ethanol, which is equivalent to a large increase in demand for corn since it is the primary feedstock. I follow the approach of Evans (2015) and use the price effects of this shock in demand to corn to connect the RFS to lake water quality. Specifically, I calculate the percent change in water quality using the following formula:

$$\%\Delta Q = \%\Delta Price\, \varepsilon_{\{wq,c\}} \varepsilon_{\{c,p\}} \quad (5)$$

where represents the elasticity of water quality with respect to cropland, and represents the elasticity of cropland to prices. I calculate (2) using both the short and long run elasticities, which can be considered lower and upper bounds.

For the change in price, I use estimates from (Hausman, 2012). Using a structural vector auto-regression (SVAR) model, the authors estimate that an increase in the demand of corn acreage for ethanol of .40 million hectares increases the price of corn and soybeans by 0.06 and 0.03 cents per cubic meter, respectively. According to data from USDA ERS, 1.29 billion cubic meters of corn were used to produce ethanol in 2005/2006, compared to 4.18 billion in 2015/2016, an increase of 2.89 billion cubic meters. Over the same period, the national average corn yield was 79 cubic meters of corn per hectare. Thus, the shock in demand is equivalent to an approximate 9.31 million hectare increase in demand for corn acreage. The above estimates from (Hausman, 2012) imply this increase in demand would increase the price of corn by $1.84 per bushel and the price of soybeans by $0.92 per bushel. I use these changes to calculate the counterfactual price index for each HUC12 in 2016. The average HUC12 experienced an approximate 58% increase in the price index because of the RFS.

Finally, I calculate the percentage change in lake water quality using both the short and long-term elasticities estimated from the previous analysis. The average lake experienced a 0.13% increase in CTSI in the short run, and a 0.27% increase in the long run. Figure 3 shows the distribution of these increases across the 123 lakes in the analysis. Thus, due to the very inelastic responses of lake water quality to cropland, and from cropland to crop prices, I find a negligible effect of the RFS on lake water quality.

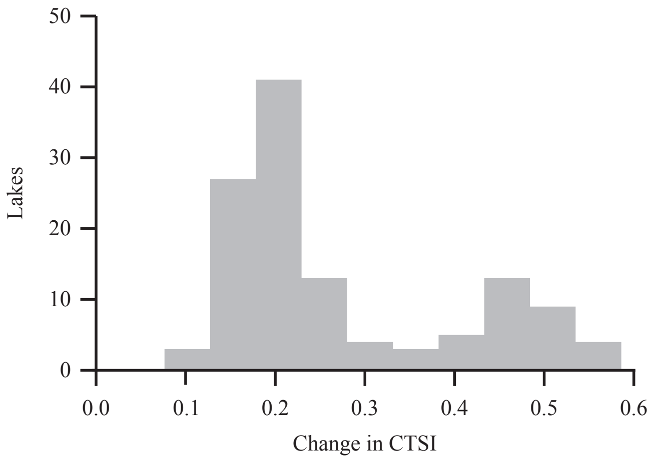

Figure 3: Estimated percentage change in CTSI due to the RFS.
Source: own estimates

Summary and Conclusions

U.S. agricultural and energy policies often have direct and indirect effects on the environment. Policies which affect agricultural land use can alter lake water quality through increased nutrient runoff. It is important to estimate these impacts to undertake thorough cost-benefit analyses of these policies.

This study focuses on estimating the effect of land use change on lake water quality in Iowa. High quality lake water measurements over 15 years are combined with satellite imagery and PRISM weather data to create a unique panel data set. Using a dynamic panel data model, I estimate the elasticity of CTSI to cropland to be 0.05% in the short run, and 0.07% in the long run, indicating that increases in cropland decrease lake water quality by a small amount. I also find a positive and significant coefficient on the lag of the dependent variable, which is evidence of a stock effect of lake water quality over time.

A second model estimated the elasticity of cropland to crop prices to be 0.066. Using these two elasticities, I estimate that the Renewable Fuel Standard decreased water quality by between 0.13 and 0.27%. The estimates may represent a lower bound since the paper only studies land use change along the extensive margin. Rather than expand cropland, farmers may alter crop rotations in favor of corn because of the RFS. Since corn requires a relatively high amount of fertilizer, the actual impact on water quality may be higher.

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Short communication

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Adoption and impact of credit-linked crop index insurance: a case study in Mali

Linking insurance with credit is a promising approach towards overcoming the main difficulties of scaling up crop insurance in Africa. The current research revealed that credit-linked crop insurance adopters in Mali were on average larger households than non-adopters, were living more often from subsistence agriculture, were less patient and less likely to produce maize, while operating on smaller farms. However, propensity score matching revealed that changes in terms of production decisions or wellbeing were limited compared to credit-users. To achieve scaling, linking crop insurance with credit should not only be beneficial for banks to limit their exposure (on a mandatory basis), but should become beneficial as well for smallholders (in terms of better access to credit, lower interest rates or less required collateral).

Keywords: crop insurance, credit, adoption, impact

JEL classifications: Q14, Q18

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Introduction

Micro-insurance can be an effective approach to smoothening income in adverse times, for example during and after droughts, and potentially a way to achieve financial inclusion of vulnerable smallholder farmers. Giving smallholders access to micro-finance enables them to invest in improved agricultural inputs to enhance farm production and ultimately household income (Karlan *et al.*, 2014). However, its uptake remains quite low in developing countries (Carter *et al.*, 2014). Being usually offered at the beginning of the growing season when farmers have least access to cash and most need for the capacity to invest, stand-alone insurance products are difficult to sell. Bundling insurance with credit is a logical strategy to address the farmers' lack of capacity to pay, but limited access to financing and the high costs of agricultural credit complicate this approach. There is a lack of understanding and little trust in insurance products, and the financial literacy of smallholder farmers is very limited. Many act out of necessity on short-term needs as opposed to long-term business strategy, with insufficient attention and means to employ risk mitigation strategies, which include, but are not limited to, insurance, that could help them to break out of the cycle of low income and low production.

In order to be financially viable, crop insurance has to be low-cost and thus at large-scale. Key to success is for providers to streamline claim handling and marketing efforts in order to minimize transaction costs. Emerging index-based insurance across Africa has proven to enable efficient claim handling. However, direct sales to individual smallholders remain a challenging task without an easily scalable solution. To reach the necessary scale, it is essential to cooperate with aggregators in the agricultural value chain who have a shared interest. Such organizations include the financial service industry (e.g., insurers, brokers, banks and MFI's), input providers (e.g., seeds and fertilizers), traders, processing industry, as well as farmer-based organizations.

Limited adoption and impact studies in the field of crop (index) insurance go beyond a one-off field experiment, and mostly focus on stand-alone insurance products. See for example a systematic review by Marr *et al*. (2016). Yet those insurance programs that are currently running are frequently marketed as bundled products (linked with input purchases and/or credit). The current research seeks to find the determinants of adoption of a credit-linked insurance bundle in Mali, and to gauge its contribution in enhancing the agricultural productivity of smallholder farmers (i.e., income smoothening and income enhancement). Mali is proving a particularly challenging context to develop the agricultural insurance market. It is the least developed insurance market in the region, with very limited capacity in the sector to develop and scale agricultural insurance products. With relatively high operational cost, agricultural insurance remains expensive. Within this institutional framework there is an increasing recognition for the potential of insurance towards building a more resilient agricultural sector, but there is little supporting policy, such as tax waivers or premium subsidy, that could help in reducing the cost of insurance.

Methodology

Bundled insurance product

We consider a typical form of a credit-linked index-based drought insurance designed and monitored by EARS (Envi-

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ronmental Analysis & Remote Sensing). The services are brokered by PlaNet Guarantee and delivered through a consortium of aggregators in Mali. The sales strategy towards financial organizations has been an inclusive approach by bundling insurance with credit directly (through MFIs) or indirectly via credit for input purchases (input providers also offering financial services). Participating aggregators made crop insurance mandatory for all clients requesting an agricultural loan. The amount of insurance premium is integrated into the loan amount, and eligible claims (i.e. index pay-outs) are deducted from the clients' debt.

The index insurance is based on Relative Evapotranspiration (RE). In principle evapotranspiration consists of two components, namely water loss from bare soil (e.g. run off) and water loss through plant leaves (i.e. transpiration). RE is a better predictor of crop growth than precipitation, and as such the explanatory value of an RE index is higher for credit risks than that of a precipitation index (Von Negenborn *et al*., 2018).

In our case in Mali, three alternative RE-based drought indices were distributed. Insurance coverage included a generic drought index policy (marketed from 2016 onwards), and crop-specific drought indices for maize and sesame (marketed from 2015 onwards). The maize coverage had a three-phase structure (i.e. germination, vegetative and flowering) with a flexible start (i.e. early start or late start). Sowing period of maize ranges from 11th to 31th of July, while harvest is typically at the end of October. The generic and sesame coverages were both based on a "single-phase" design with a fixed start. Sowing sesame starts on the 11th of August while harvest starts on the 11th of October.

In 2015 and 2016, 7,282 and 6,102 smallholders respectively were insured. Initially, maize coverage was most popular (54% maize versus 46% sesame insurance policies), but after launching the generic product sesame insurance became more prominent (28% maize versus 44% sesame versus 28% generic policies). The average insured plot size and insured (input) amount per smallholder was approximately 1 hectare and 50,000 CFA franc (76€). Average premium per farm amounted to 5,535 CFA franc (8.41€) and depended on the geographical zone, for which premium ranged between 10% in the least drought prone climatic zone (south) up to 14.8% in the most drought prone climatic zone (north).

Adoption and impact design

The current adoption and impact research would cause minimal interference with the initiatives that would normally be undertaken by the broker and aggregators in Mali. Impact was assessed by means of a cross-sectional double-difference design by sampling adopters in the access villages and non-adopters in both access villages and control villages. In total, 15 villages with access to the credit-linked index-based insurance product were randomly sampled from a list of all targeted villages. Since the total number of insured villages per aggregator was limited, several aggregators which offered identical terms and conditions of credit-linked index insurance were included. For each access village, a control village was randomly selected from non-access villages within the same circle (administrative unit) and climatic zone (as defined by EARS). In each access village, 8 insured farmers were randomly selected from the list provided by the aggregator, and 8 non-insured farmers were selected at random from a village census provided by local authorities. In each non-access village, we interviewed 16 farmers selected at random from a village census provided by local authorities. The Android-based survey was conducted after the harvest season in March 2017 by an independent contractor (GREAT).

The household survey included both demand and impact indicators. Demand was hypothesized to be influenced by numerous explanatory variables including household characteristics, credit and liquidity constraints, preferences and individual characteristics, and farm characteristics. Household characteristics included education of household head (in years), gender and age of household head, whether household head was elder, number of household members, and distance to the nearest drinking water source (minutes). Credit and liquidity constraints were derived by means of a wealth index (a principal factor of assets owned by the household constructed following Sahn and Stifel (2003)), whether the household received income from a working family member, whether the main occupation of the household head was subsistence agriculture, and whether the main occupation of the household head was trading. Preferences and individual characteristics were elicited based on a series of hypothetical lotteries to deduct risk aversion level, and standardized measures of patience and cognitive ability following Falk *et al*. (2016). Finally, farm characteristics entailed information on maize production and total farm size (in hectares). Impact indicators comprised production and financing decisions in the last agricultural season, and wellbeing in the past 12 months. Production decisions focus on average organic fertilizer use (kg/m^2), average chemical fertilizer use (kg/ha), average pesticide use (l/ha), use of improved maize variety, and percentage of total farm size dedicated to growing maize. Financing decisions captured total outstanding debt of the household (thousands West African CFA franc) and the percentage of total outstanding debt used for investment (as opposed to consumption). Binary wellbeing indicators classified whether households were faced with a situation of food shortage (i.e. a situation where there was not enough to eat), hunger (i.e. someone in the household went to sleep hungry at night) or money shortage (i.e. someone in the household faced shortage of money).

Using data from access villages, we obtained weights for the determinants of adoption, and used them to predict the likelihood of insurance adoption of each farmer (crucially including those without access to insurance). Furthermore, we estimated the effect of the insurance on the production decisions of comparable farmers by interacting the predicted probability with a variable indicating access to insurance (i.e. counterfactual by means of propensity score matching (Rosenbaum and Rubin, 1983)).

Results

Following the sampling design, and adjusted for practical limitations, in total 485 smallholders were surveyed, of which 247 in access villages, of which 104 credit-linked insurance adopters. Balance tests along adoption determinants between villages with or without credit-linked insurance access revealed some selective attrition in our sample. A smaller proportion of households cultivated maize in villages with credit-linked insurance access (76.9% versus 86.6%, P<0.01) in which the main occupation of the household head was more likely subsistence agriculture (84.2% versus 75.2%, P<0.05).

By means of a multi-variate probit estimation, the probability of insurance adoption cases could be predicted 70.4% successfully (Table 1). Adopter households were on average larger than non-adopters (23.96 compared to 20.22 household members) at a significance level of P<0.01. Adopters were more often living from subsistence agriculture (P<0.05), were less patient (P<0.05) and were less likely to produce maize (P<0.05). Moreover, adopters operated on smaller farms (P<0.10).

Table 1: Determinants of credit-linked insurance adoption.

	Marginal effects	
HH head years of education	0.014	(0.033)
HH head female	0.299	(0.985)
HH head age	0.001	(0.008)
HH head elder	-0.012	(0.294)
HH size	0.029***	(0.011)
Distance to water (remoteness)	0.007	(0.017)
Wealth	-0.035	(0.091)
Paid job	0.105	(0.192)
Subsistence agriculture	0.546**	(0.245)
Trading	-0.006	(0.187)
Risk aversion	0.071	(0.110)
Patience	-0.119**	(0.055)
Cognitive ability	-0.099	(0.065)
Total farm size ha	-0.011*	(0.006)
Grow maize	-0.321**	(0.157)
N	240	

Probit marginal effects. SE clustered at the village level in parentheses. * p<0.10, ** p<0.05, *** p<0.01.
Source: own data

Impact of adopting the insurance on a range of adoption decisions is indicated by the coefficients in the first row of Table 2 (Access × Pr(Adopt)) and indicated no measurable statistical impact. This is not surprising since the insurance, mandatorily linked with credit, was not arranged individually but by aggregators, and most of the insured respondents were even not aware (anymore) of being insured.

The direct impact of adopting the insurance on various indicators of wellbeing is shown by the coefficients in the first row of Table 3, and is somewhat mixed. Adoption of the insurance was correlated with lower probability of facing shortage of money, which is however likely to be due to its bundling with credit rather than to the insurance itself. There is no statistically significant effect on food security.

Table 3: Impact of credit-linked insurance on on wellbeing.

	(1) Food shortage	(2) Hungry	(3) Money shortage
Access × Pr(Adopt)	-0.690	0.283	-1.800***
	(0.858)	(0.982)	(0.599)
Access	0.398	-0.210	0.890***
	(0.379)	(0.462)	(0.238)
Pr(Adopt)	1.060	1.374*	0.942**
	(0.673)	(0.715)	(0.470)
N	468	468	468

Probit marginal effects. SE clustered at the village level in parentheses. * p<0.10, ** p<0.05, *** p<0.01.
Source: own data

Discussion

The full impact of adopting the insurance on wellbeing should truly manifest itself when drought hits. To estimate the effect of the insurance on farmers' wellbeing, we further interact access to insurance and the probability of being insured with a variable indicating a spell of drought during the last agricultural cycle (as measured and defined by the drought index used in the insurance). Outcomes suggest that crop insurance reduces the probability of food and money shortages in times of drought. However, when taking into account the intensity of the drought, the effects on food security become statistically negligible. When measuring drought as perceived by the respondents no significant effects are detected whatsoever. Adopting the insurance might nevertheless mitigate the severity of drought in other ways (or in a magnitude not detectable in our sample size), as it reduces the probability that the respondent perceives overall conditions as drought.

Crop insurance has a longer history in the EU than in Africa, and plays a significant role in compensating yield losses caused by climatic risks, with or without subsidies

Table 2: Impact of credit-linked insurance on production decisions.

	(1) Organic fertilizer	(2) Chemical fertilizer	(3) Pesticide	(4) Improved maize	(5) % land maize	(6) Total debt	(7) Debt for investment
Access × Pr(Adopt)	-0.320	-42.536	2.150	-0.041	0.060	-35.069	-28.966
	(0.237)	(88.349)	(2.591)	(1.111)	(0.528)	(652.545)	(21.552)
Access	0.150	37.451	-0.524	0.003	-0.111	0.609	9.438
	(0.111)	(44.485)	(1.333)	(0.542)	(0.208)	(360.561)	(8.684)
Pr(Adopt)	0.063	46.407	-0.470	-0.503	-0.863*	142.005	11.827
	(0.089)	(54.664)	(0.780)	(0.768)	(0.459)	(516.010)	(11.546)
N	385	385	385	468	468	467	125

Tobit (1-3, 5-7) and probit (4) marginal effects. SE clustered at the village level in parentheses. * p<0.10.
Source: own data

at Member State level or by using Article 37 of the Risk Management Toolkit under the Common Agricultural Policy. However, the tools available in EU Member States to manage crop yield risks through insurance are very diverse (Meuwissen *et al*., 2018). There are single-peril insurance tools (mainly hail insurance) and multi-peril risk insurance schemes that secure against a wider range of weather perils. Yet, drought is often excluded from most combined peril schemes or only partially included. Moreover, the insurance cover is generally not marketed as a credit-linked package (yet financiers might request to insure crops with a separate financial product). Although recent developments in index-based insurance products offer a potential for coping with crop losses, targeted index-based insurance products are offered only in a few Member States. Prominent examples of index-based drought insurance are marketed in Austria for some specific crops and grassland (Url *et al*., 2018) and specific crops in Lithuania, while in France and Spain index-based insurance for deprived pasture yields is available. Other examples can be considered more as pilots to test product feasibility (e.g. drought index cover in Germany). The current paper serves as an illustration on index insurance, for which only few examples exist in Europe so far.

Good partnerships are essential in overcoming the main difficulties of scaling up micro-insurance in Africa. Microfinance institutions and banks benefit from linking credit supply with mandatory insurance uptake directly. Financial institutions have a vested interest and the market power to enforce mandatory bundles that provides adequate coverage for climate related risk. Smallholders are less exposed to weather risks if they obtain insurance, which reduces their default risk. By reducing agricultural risk, financial institutions are able to increase their agricultural portfolio, absolutely and proportionally. Ultimately, this should result in a more competitive loan provision in the agricultural sector, manifested as better access to credit for producers, lower interest rates or less required collateral.

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