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# Public funding for public goods: A post-Brexit perspective on principles for agricultural policy

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ABSTRACT

In early 2019 the United Kingdom is due to leave the European Union and with it the Common Agricultural Policy. The UK Government has announced its intentions to formulate a novel agricultural policy following the principle that public funding should be restricted to the provision of public goods. However, the acceptance, interpretation and application of this principle is the subject of intense debate. We overview the background to this debate, reveal the major flaws in present policy and identify and provide our answers to three key questions which future policy must address: (1) What are the farm related public goods that public money should support?; (2) How should that spending be allocated?; (3) How much should be spent? We believe that these questions and their answers will be of general interest beyond the UK.

## 1. Introduction

Following the Brexit referendum the United Kingdom is due to leave the European Union by March 2019. While this will affect all aspects of the UK economy, probably no sector will be impacted more profoundly than agriculture. For more than four decades the relationship between the UK Government and the farming sector has been dominated by the EU's Common Agricultural Policy (CAP) which has determined the public subsidies paid to farmers. While a commitment has been given to keeping these subsidies in place for the duration of this parliament (Downing et al., 2018), expected to be until March 2022, the Government has made it clear that major changes in policy are imminent. The recent publication of a Command Paper (Defra, 2018a) consulting upon a proposed Agricultural Bill expected within the current session of Parliament (Downing and Coe, 2018) has signalled an intention to radically shift the emphasis away from general support for agricultural activities and towards the longstanding objective of targeting public money towards the provision of public goods (H.M Treasury, 2007, 2013), in particular those environmental improvements that are the focus of the Government's recent 25 Year Environment Plan (H.M. Government, 2018). This radical shift in policy intentions is of significant public interest, with more than 44,000 responses to the consultation (Defra, 2018b), and we believe, is to be welcomed as a key element in delivery of the Government's overarching objective to ensure that the present generation is the first to leave the natural environment in a better state than it inherited (H.M. Government, 2011).

## 2. Why business as usual is not an option: the shortcomings of CAP

Whether you are pro- or anti-Brexit, withdrawal from the EU's CAP should be welcomed. CAP succeeded at promoting food production in post-war Europe, but inherent flaws in its design meant that this came at massive cost. At its peak the CAP cost 73% of the EU's budget and still accounts for 38% of total spend (EU-ARD, 2017; IoG, 2018) and provides nearly half of farm income (Lang et al., 2017). But the costs are not purely financial; despite 25% of CAP support being paid through its Pillar 2 Rural Development fund which supports a variety of Agri-Environment Schemes (AES) (Science for Environment Policy, 2017), these have been criticised as poorly targeted, relatively ineffective (Sutherland, 2002; Davey et al., 2010) and fundamentally compromised and overwhelmed by the 75% of funding which goes directly to farms under the more conventionally focused Pillar 1 of the CAP (Pe'er et al., 2014). This has meant that, despite numerous and ongoing reforms (Howarth, 2000; Hart et al., 2018), the period of the CAP has been one of unprecedented levels of environmental damage. Since the UK first joined the CAP in 1973 British farmland birds have declined by 56% (Harris et al., 2018) with iconic species such as the corn bunting suffering a 90% fall in numbers (*ibid.*); farming has contributed three-quarters of sediment-load and around 60% of nitrate pollution in UK water ways (Bewes et al., 2014; Holden et al., 2017); and, as the Secretary of State has pointed out, over-use of agricultural land means that we may have just 30–40 years before farm soil fertility

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is exhausted (Guardian, 2017). As Mitchell (2017) notes, "Overall, agriculture is a major source of greenhouse gas emissions, the main polluter and user of water, and the primary driver of habitat destruction and species loss" (p.6).

CAP was designed as a public subsidy for the private production of a private good: food. This results in the public paying twice; once as tax payers and again as food purchasers. Despite suggestions to the contrary (e.g. NFU, 2018), joining the CAP entailed the acceptance of trade tariffs which actually sent UK food prices soaring: during the first decade of CAP subsidies in the UK, food prices rose at a rate of nearly double that of comparable countries (OECD, 2018)[1]. While aiming to maintain the *capacity* to produce higher levels of food is potentially useful in a volatile world where demand and supply are imperfectly known (e.g. Patel, 2009; Forbord and Vik, 2017), subsidising *over-production*, particularly at times of ample supply, is poor policy.

It is also well recognised that the CAP has not even benefitted the majority of farmers (Jambor and Harvey, 2010; Ciaian et al., 2015; Dowler and Carter, 2016). The bulk of its funds are paid through the Pillar 1 Basic Payment Scheme. However, because this is allocated on a per hectare basis this means that three quarters of these funds go to just one quarter of farms[2]. These are the largest and often richest farms in the country and stand in sharp contrast to the 50% of farms who share just 10% of these subsidies. Fig. 1 illustrates this inequity, comparing how payments are currently allocated (the upper cumulative payments curve shown in blue) with the situation if payments were evenly spread across farms (the lower straight line shown in green). This inequality is reflected in both the stark difference between these lines and the standard measure of distribution; the Gini coefficient, a measure with a value of 0 if everyone got an equal share of payments and 1 if a single individual takes all funds. The calculated Gini value of 0.61 shows just how unequal the present system of farm subsidies is (all calculations described in the Appendix A). Wider comparisons further underline the failure of the CAP to improve the situation of ordinary farmers who only earn around two-thirds of the incomes of those in other sectors; a situation which has not improved in more than two decades (ONS, 2017).

Quite clearly then the current system of public support for farming is indefensible for the environment, for taxpayers, for food consumers and even for most farmers. A radical revision is long overdue. What then are the principles that should guide this revision?

## 3. A new deal for public spending on UK farming: the key questions

A consideration of public spending on the UK farming sector requires that we address three key questions:

(1) What are the farm related public goods that public money should support?
(2) How should that spending be allocated?
(3) How much should be spent?

These questions, and their answers, are inter-related. Addressing Question (1) requires a clear understanding of the benefits that farming

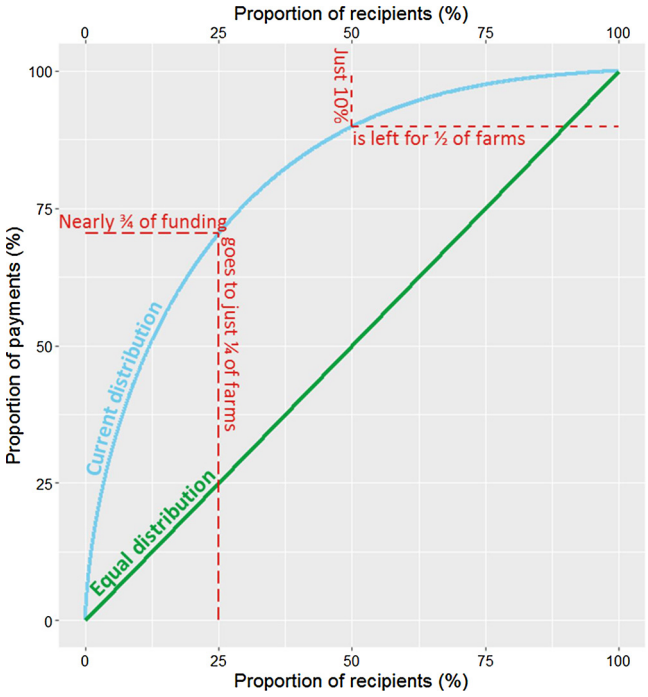


**Fig. 1.** Cumulative distribution of subsidies paid under the current CAP Basic Payment Scheme (blue line) and how this curve would look with equal payments to all farmers (green line). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article). Data from Defra, available at http://cap-payments.defra.gov.uk/Download.aspx ; see Appendix A for calculation and data details.

can provide, which of these are private goods best provided by markets, and which are public goods requiring public support. Ultimately, Questions (2) and (3) will determine the effectiveness of any subsidy scheme. Question (2) addresses two issues. First, the way in which funding is allocated determines both its uptake by farmers (e.g. heavy bureaucracy, forbidding application processes or risky payments may deter involvement in publically funded schemes[3]) and the value for money which it delivers (e.g. introducing elements of competition for funding and, where reasonably possible, payments for outcomes rather than actions, can substantially increase the efficiency of funding). Second, the degree to which farms can deliver some public goods (particularly those related to the natural environment) varies markedly between locations (Bateman, 2009). Targeting funds to those locations which yield the highest net benefits can significantly improve value for money to the taxpayer. The current Farming Consultation (Defra, 2018a) says little about Question (3), however the ability to efficiently target spending on farm subsidies will be a major determinant of the level of public goods provided by different levels of budget and should in turn partly determine the size of that budget.

### 3.1. What are the farm related public goods that public spending should support?

Agriculture is a private enterprise and food is sold in markets, directly to consumers, and is therefore by definition (and according to official government guidance) a private, rather than a public, good

[1] CAP also caused farmland prices and rents to rise at an unprecedented rates as they capitalised subsidy values (Hyder and Maunder, 1974; Traill, 1979, 1984), an effect that has not been dissipated by subsequent reforms and has been seen across the EU (Guastella et al., 2017; Milczarek-Andrzejewska et al., 2018; O'Neill and Hanrahan, 2013). It is important to note that this capitalisation benefits land owners and that over 30% of farmers are tenants and do not own the land they farm (Eurostat, 2018).

[2] Indeed half of Europe's farms share just 5% of CAP direct payments (Matthews, 2016). In contrast the 10% most supported farms (750,000 farms) across Europe capture 55% of all direct payments which accounts for some 15% of the entire EU budget (ibid.).

[3] There are of course a diversity of factors which determine farmers' provision of public goods (Zimmermann and Britz, 2016; Weltin et al., 2017; Inman et al., 2018). Nevertheless, evidence shows that the main motivation for participation in agri-environmental schemes is economic (Pavlis et al., 2016; Howley, 2016).

(H.M. Treasury, 2018)[4]. Public subsidy of private production is extremely unusual (especially at the rates indicated previously) and, as noted above, runs the risk of consumers paying twice, once as purchasers of food and again as taxpayers. Access to food is in the public interest and preventing food poverty through social security payments or other actions is an extremely worthy cause. However, food producers typically aim to sell to the highest bidder, not the most socially deserving consumer. Heated pleas for the public subsidy of food production will not alter this[5]. Therefore, it is highly inefficient to attempt to deliver this food security through the subsidy of food production itself, particularly because, as noted earlier, the tariffs inherent in the CAP have actually caused food prices to go up rather than down. Moreover, food prices are heavily influenced by trade, and as such the nature of trade deals post-Brexit will likely have a far greater impact on the prices consumers face than will any production subsidy scheme (Swinbank, 2017).

Indeed, as noted by the House of Commons (2007, p.3) the "only long-term justification for future expenditure in the agricultural sector is the provision of public benefits", a position accepted by many land owners and increasingly by farmers (CLA, 2018; Commercial Farmers Group, 2018). The main public good highlighted in the Government's farming consultation document is environmental improvement (Defra, 2018a). Environmentally related public benefits which can be produced by farming include, but are not limited to:

- Improved soil health
- Water quality improvement
- Water quantity regulation
- Flood risk reduction
- Climate change mitigation through the reduction and storage of greenhouse gas emissions
- Other air quality improvements such as reducing ammonia emissions
- Conservation and enhancement of biodiversity
- The provision of amenity views
- Recreational access
- Improvements to physical and mental health
- Supporting provision of the above environmental public goods through diversification into other production with high public good characteristics (e.g. woodland) and/or compensation for environmental damage elsewhere in the economy (e.g. delivering net environmental gains from housing developments).

The type and level of public good benefit will vary across location in line with the underlying variation in the natural environment and support levels should reflect that variation. Some areas (e.g. peatlands) will be valuable for carbon storage while others will not. Similarly, benefits will often vary according to the proximity of populations. So a woodland planted near to a deprived urban area will yield far greater recreation and mental health benefits than one established in some remote location. Furthermore, many of the environmental benefits listed above can be co-created, by which we mean that the use or management of farmland can be arranged to generate several of these benefits at the same time. For example, an area which is left unploughed to reduce diffuse water pollution might also deliver flood risk reductions, wildlife habitat, carbon storage and recreational benefits (Bateman et al., 2013, 2016). It is the net public benefits to society which farming can generate that should form the focus for, and determine the level of, future public subsidies. As discussed in the following section, data availability and the development of decision support tools increasingly allows decision makers to eschew simplistic rules for determining public benefits and hence target support payments to those locations where they will be most cost-beneficial.

To reduce administration burdens on both farmers and public institutions, payments to farms should ideally be made through a single channel, but with separate policies explicitly targeting each public good (Alix-Garcia et al., 2015) and coordinating their co-delivery. General and untargeted actions (such as those required under the Entry Level Stewardship Scheme) should be avoided as they are likely to deliver poor value for money (Hodge and Reader, 2010).

There are a number of nuances which any subsidy scheme would have to address to be successful. For example, in some cases it may be efficient to support the development and uptake of techniques which increase productivity (output per unit input) at the same time as lowering environmental impacts (Ewers et al., 2009; Phalan et al., 2016; Boyd, 2018). Indeed, linking such productivity gains to greater 'land sparing' (taking land out of agricultural production; Green et al., 2005; Phalan et al., 2011) may prove an important route for achieving the objectives of the Government's 25 Year Environment Plan (H.M. Government, 2018), such as delivering on agricultural carbon emission reduction targets (Lamb et al., 2016). Approaches which make environmental improvement commensurate with higher farm profitability are also to be strongly encouraged. The large majority of farms will still have the profitable production of food as their primary focus. However, the level of any public subsidy has to be orientated towards the consequent improvement in public goods (here environmental quality) rather than increasing the private production of food. So, technology which raises output while either directly or indirectly delivering a net improvement in environmental public goods is a perfectly acceptable target for public support. But conversely technology which fails to deliver such public goods or even worse degrades the environment should not receive public subsidy. Throughout all of these changes the regulation of environmentally damaging activities will remain an important policy tool into the future.

While such productivity enhancements are important, the direct delivery of environmental benefits is likely to be the major public good provided by farms and therefore the main focus of public subsidy. However, at least two other issues should be considered. First, farms play an important part in rural communities, providing employment and livelihoods as well as a less tangible social role. Second, there is substantial evidence that, in the absence of any public funding, certain sectors of the farming community would face substantial economic hardship (Colston, 2018). The alleviation of such hardship is clearly of social benefit in its own right. Moreover, even from a purely environmental perspective, without a viable economic future for farming it is feasible that some of the environmental benefits highlighted above would not be delivered in some areas of the country.

[4] A "Public good" is both non-excludable (i.e. non-paying consumers cannot be prevented from accessing it) and non-rivalrous (i.e. use by one individual does not reduce availability to others), an environmental example being the air we breathe. At the other extreme food is a "Private good" as it is both excludable (i.e. consumers have to pay to access it) and rivalrous (i.e. use by one individual precludes its use by another). It is notable that the Secretary of State for Environment, Food and Rural Affairs, the Rt. Hon. Michael Gove MP, declined to classify food as a public good when overtly asked to do so during House of Commons Committee evidence sessions (House of Commons, 2016; Q280). Somewhat in between the public and private good extremes, "Common-pool resources" are non-excludable but rivalrous and would traditionally have included open-ocean fish stocks which anyone can fish but in doing so availability can be reduced if that stock is extracted too rapidly. Because both public goods and common-pool resources are liable to be over-used a widely applied approach to their conservation is to change their property rights to resemble those of private goods, for example by imposing fishing quotas or imposing costs upon those who emit pollutants. For completeness, "Club goods" are excludable but non-rival (e.g. satellite signals). For further reading see Varian (1992).

[5] A number of those appearing before the recent Environment, Food and Rural Affairs Committee evidence sessions argue for public subsidy of private food production on the grounds that this will improve the diet of the nation (House of Commons, 2018). Given that such subsidies do not change the price of food in the shops it is self-evident that changing the provenance of food production will have little impact upon its consumption and be a massively inefficient means of promoting access to food for the poor.

Farm financial collapse is a very real threat for some farming communities. While temporary abandonment of land is a possibility, long term this is more likely to lead to the consolidation of smallholdings into larger units. The environmental (and indeed social) consequences of such change need to be considered if we are to deliver the long term vision of the 25 Year Environment Plan. Given this, there is a case for the provision of an income safety net[6] linked to the production of environmental public goods (Bateman, 2017). Furthermore, such an innovation is readily affordable, does not undermine the targeted funding of specific environmental benefits, and does not contravene WTO rules[7]. As Fig. 1 shows, current subsidies are massively skewed towards a small fraction of farmers. If we spread this out more evenly the potential exists to both increase the typical farmer's income, and set aside a greater amount of public funding for the provision of public goods. To illustrate this potential win-win, consider a case where we pay all farmers an equal safety net income set at the current median level of CAP subsidy received by farmers[8]. This means that the average farmer has to be at least as well as off as they currently are, and guarantees the half of farmers currently receiving the lowest levels of support a relatively significant increase in income. Keeping overall public spending levels the same, such a scheme would still leave more than £1.5bn for the targeted support of public goods such as environmental improvements: almost a tripling of the current levels of investment in the environment under CAP (details in Appendix A). Given that this latter amount is also available to support farms, then once we add in the safety net payment, it is clear that the large majority of farms could substantially increase their support payment incomes under such a scheme.

An income safety net would directly address pressures to avoid short term socio-economic hardship for an industry where few farmers can recall a time before public subsidies and where reliance upon such subsidies is now extreme. Nevertheless, longer term the expectation would be to see safety net payments taper down over time with funding transferred into targeted public money for public goods payments. An exception would be where certain environmental benefits are both particularly difficult to quantify (e.g. landscape amenity values are currently more contested than those associated with say recreation) and where payments are easier to administer through straightforward income based approaches.

While safety net measures would typically benefit economically vulnerable farms, the move to a 'public money for public goods' approach does not penalise large farms. Indeed, given that the potential for public good provision increases with area, such farms would have the opportunity to earn substantial subsidy payments from environmental improvement. The approach we propose would bring an end to the current inequity of a system that provides large farms with higher subsidies simply because they are large. Instead it offers all farms, large and small, the opportunity to earn public subsidy income in return for the provision of public goods. Indeed, even farms in regions with very profitable agriculture could still benefit substantially from our proposed subsidy model (Peh et al., 2014).

Some have argued that animal welfare is also a public good (Nurse, 2016; MRCVS, 2018). Whether or not this is the case, there is the clear potential for moral hazard if public funds were used to prevent low levels of animal welfare (in effect paying individuals to not treat animals badly). This then mitigates in favour of the use of regulations, backed with trade restrictions against the import of food produced to lower standards, as an efficient approach to delivering high standards of animal welfare.

### 3.2. How should public spending on farm public goods be allocated?

As noted above, there are several considerations in the allocation of public support for environmental public goods. While it might seem more natural to address the amount of subsidy first and then consider its allocation, this is not the best approach with regarding to environmental improvement payments. The natural environment is highly diverse and the same level of spending allocated to different places can yield widely differing levels of benefit. By first ensuring that we allocate funds appropriately we can avoid highly wasteful misallocations and thereby ensure that budgets go further and generate much greater value for money.

Current approaches to agricultural subsidy have been heavily criticised as overly bureaucratic (Parker, 2017) and one of the advantages of the per farm income safety net approach proposed above is its ease of operation. As detailed earlier, future schemes have to avoid excessive bureaucracy as the time taken and challenges involved in some schemes are clearly a deterrent to participation (Engel, 2016). Linked to this, if potential payments are seen to be at risk then this will also deter farmers. So if there is a chance that minor errors in form filling will result in payments being disbarred then this will reduce participation. The issue of risk also affects the very worthy desire to try and move the basis of payment away from funding actions and towards rewarding outcomes. There is a clear inefficiency associated with paying for actions which may not deliver the desired benefits; obviously paying for delivered benefits is far more efficient and mimics private markets in which consumers pay for what is delivered. However, there is always a risk that a given activity may not deliver a desired outcome. For example, if a farmer provides high quality bird habitat in an appropriate location, but no birds happen to roost in that habitat then, under a strict payment for outcomes regime no subsidies would be provided. Clearly it is reasonable for risk to be shared between the farmer and the taxpayer in many situations, otherwise environmental schemes will not be engaged with.

A key issue will be the targeting of subsidies to those locations which support the best value for money in terms of the public benefits delivered, ensuring that the efficiency can be delivered, in line with the House of Commons (2007) statement. Here advances in monitoring, data availability, modelling and decision support can provide very considerable assistance to decision makers such as the UK's Department for the Environment, Food and Rural Affairs (Defra) who are ultimately responsible for subsidy payments. As highlighted in the Government's 25 Year Environment Plan, Defra have already invested in such decision support tools (e.g. the ORVal model; see H.M. Government, 2018) and more are in development (e.g. Rose et al., 2016; NEVO, 2018). The natural environment is highly variable not only in its physical nature but also in the benefits it can deliver. This information needs to be used to target at least some public expenditure. The state of this information

[6] Like all rules, some refinement is needed. For example, non-economic 'hobby' farms should be excluded and the division of existing farms to increase subsidies should be de-incentivised by simply ensuring that such actions would also divide subsidy payments.

[7] A reallocation rather than overall increase in subsidies does not fall foul of WTO rules provided it is not a hidden production subsidy. While there is a common misconception that WTO rules prohibit environmental subsidies this is not in fact the case. Annex 2 Section 12 of the 1994 WTO Agreement on Agriculture notes that eligibility for agri-environmental payments "shall be determined as part of a clearly defined government environmental or conservation programme and be dependent on the fulfilment of specific conditions under the government programme, including conditions related to production methods or inputs", and that "the amount of payment shall be limited to the extra costs or loss of income involved in complying with the government programme" (GATT, 1994, p. 63). The clear eligibility of any "loss of income" means that a reallocation of existing eligible subsidies (such as those under the CAP) is permissible under WTO rules. For further discussion see Hasund and Johansson (2016), and Bureau (2017).

[8] In these calculations we set this as the median level payment (i.e. the amount which at least 50% of farms received) under the Basic Payment Scheme in 2016 which was £7734 per annum. This example is purely illustrative and does not imply a prioritisation of safety-net over environmental improvement payments. Ultimately public payments should reflect the level of public goods they generate.

is such that the piloting of targeted spending could commence in the short term, before being rolled out nationally.

Linked to this, there is very considerable potential for Defra to both reduce bureaucracy and improve efficiency through the use of competitive tendering for public goods provision. There has been considerable use of Payments for Ecosystem Services (PES) mechanisms such as procurement auctions where farmers are asked to submit bids to undertake environmental improvement works (Latacz-Lohmann and Schilizzi, 2005). Competitive bidding between providers typically results in greater value-for-money for the public. Moreover, in almost all other areas of government it is highly unusual for public money to be spent *without* engaging such a procurement process for contracts (H.M Government, 2015). However, PES mechanisms can also be designed to promote co-operation across farms (Elliott et al., 2015). Such 'landscape' scale collaborations are crucial to the provision of a number of public goods, such as biodiversity and visual amenity, and are already supported through the Countryside Stewardship Facilitation Fund (EAFRD and Natural England, 2017) which the 'Landscape Pioneer' case study for the 25 Year Environment Plan seeks to build upon (SWEEP, 2018).

It will also be necessary to use contracts which are sufficiently long in duration to foster the provision of public goods, but not so long as to discourage farmers from enrolling through fear of losing the ability to vary their future activities (Broch and Vedel, 2012). Moreover, it is also necessary to consider the effects of a subsidy scheme on farmers who are not enrolled within it (Ferraro, 2011). Under a fixed budget, higher individual payments mean more farmers are keen to join the scheme, but fewer actually can. Those unable to join the scheme may still maintain their environmental quality in the hope of winning contracts in the future.

Contracting also enhances the considerable scope that exists for involving the private sector and NGOs in the funding of environmental public goods. Such approaches have already secured the involvement of various water companies in funding farmers to improve local water quality (Day et al., 2013; Smith et al., 2017; Bateman et al., 2018). These private PES contracts deliver both private benefits, through reduced water treatment costs to companies and enhanced incomes to farmers, and public benefits, in the form of cleaner rivers. Furthermore, PES fall outside the jurisdiction of WTO rules (Franks, 2016).

Increased private sector funding of the public environmental benefits supplied by farming could also be generated through the involvement of the building sector. The November 2017 Budget committed the Government to building 300,000 new homes each year in England alone (H.M Treasury, 2017). However, The Government has also proposed that the development of new buildings should foster net environmental gains (Ministry of Housing, Communities, and Local Government, 2018). There is a clear potential for joined-up Government action if these development policies are integrated with the proposed new Agricultural Bill. Given the massive scale of housebuilding envisaged by the Government, it seems inconceivable that any net environmental gain requirements could be delivered without recourse to the more than 70% of UK land under agricultural production. If planning agencies are geared up to facilitate such a compensation scheme, this could bring massive business sector funding into both agriculture and environmental improvement. Such integration requires that we tackle long standing research challenges regarding the nature and targeting of such environmental offsetting schemes: should they benefit nearby communities, society in general, a wide range of environmental benefits (Badura et al., 2017) or just wild species (Lawton et al., 2010)? Moreover, The Government must have a more nuanced approach than "…targeting public funds at projects that provide purely public goods." (p. 144, H.M. Government, 2018). While the sentiment may be worthy of praise, an overly simplistic demarcation will limit the extent to which synergies between public spending, private incentive and offsetting can be fostered.

### 3.3. How much should be spent? The appropriate level of public subsidy for farming

Arguably the most major issue concerns the level of public subsidy going into agriculture. As noted above, current public subsidies under the CAP amount to about £3bn per annum, equivalent to about half of UK farm incomes (Lang et al., 2017). There is a commitment to maintain this level of spending, at least under the current Parliament (Defra, 2018a). This is a substantial sum with a potentially high opportunity cost and it is unusual for the public purse to provide such a high proportion of income for a sector of the economy. Furthermore there is a lack of systematic evidence regarding the cost-effectiveness (let alone cost-benefit) of agri-environmental schemes (Ansell et al., 2016). Given the major change in policy proposed by the Government, the need for such evidence is now acute and is recognised in the 25 Year Environment Plan commitment to a second National Ecosystem Assessment (H.M. Government, 2018) beginning in 2022.

Nevertheless, even in the absence of such systematic assessment, there is ad-hoc evidence to suggest both that the costs of delivering environmental policy objectives are significant (CCRI, 2010) and that the benefits of public investments in environmental improvements can be substantial (Defra, 2018a; UK-NEA, 2011; Natural Capital Committee, 2017). These gains include both environmental enhancements (RSPB, 2013; Batáry et al., 2015; Science for Environment Policy, 2017) and their consequent wider social and economic benefits (Mills, 2012; Courtney et al., 2013; Lastra-Bravo et al., 2015). In a recent assessment Defra (2018a) estimated that every £1 invested through *current* agri-environment schemes delivers roughly £4 worth of benefits; while Natural Capital Committee (2015) suggest that much larger returns on investments are achievable under a *re-designed* agricultural policy which targeted spending to those areas which deliver the greatest benefits. Future refinements such as competitive allocation mechanisms and (where feasible) outcome-based payments could further bolster the social benefit returns to public spending.

## 4. Concluding remarks

While UK interventions in agriculture under the CAP have represented at best poor value for taxpayers and at worst the subsidy of environmental degradation, we argue that a redesigned relationship between the state and the farming community has the potential to deliver good value for money if orientated according to the principle of public money for public goods. However, this requires that such subsidies are redirected away from support for private production and towards provision of the environmental and other public goods that farming can supply. To deliver this we need to recognise what those public goods are and how the allocation of public money can best be organised to ensure their delivery. This will require the incorporation of contemporary decision support approaches to the targeting of subsidies, new thinking in the mechanisms used to allocate funds, and a willingness to adopt a joined-up approach across Government departments. The potential prize is considerable; a true win-win which benefits the natural environment, tax payers and wider society, and the farming community itself.

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## Appendix A

Raw data for the Gini coefficient and safety-net income calculations use Defra's 2016 figures available at: http://cap-payments.defra.gov.uk/Download.aspx

### *Gini coefficient*

Referring back to Fig. 1, the Gini coefficient is calculated as the area between the "Current Distribution" curve and the "Equal Distribution" curve, divided by the area of the triangle under the "Equal Distribution" curve. The "Current Distribution" curve cumulates the percentage payments made under the CAP Basic Payment Scheme (BPS) ordered from the farm that received the highest payment to that which received the lowest. The area under this curve is calculated by multiplying this list by the percentage that each farm represents of the 145,029 farms which are subsidised under BPS (0.00689%), and sum all of the resulting values. We then subtract the area of the triangle under the "Equal Distribution" curve and then divide this number (the area between the two curves) by the area of the triangle under the "Equal Distribution" curve to obtain the Gini coefficient.

### *Safety-net income*

The median total annual amount of subsidy received by each farm under the Common Agricultural Policy is calculated. We multiply this payment (£7734) by the 154,744 farms currently listed as receiving some form of subsidy from Defra (note that this includes 9715 farms who do not receive BPS; data available at the above hyperlink), to get the total expenditure necessary under an income safety net to ensure that the median (i.e. 50th percentile) farm is at least as well off as at present. We subtract this amount (£1197 million) from the total expenditure under CAP in 2016 (£2862 million) and compare the amount left (£1665 million) with the amount that is currently directed towards environmental benefit under Pillar 2 (£600 million).

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