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Policy Reform and Agricultural Land Abandonment

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Abstract

This paper examines the potential impact of agricultural and trade policy reform on land-use across the EU focussing particularly on the issue of land abandonment. Using a novel combined application of the well established CAPRI and Dyna-CLUE models it estimates the extent of change across Europe under removal of Pillar 1 support payments and trade liberalisation. Overall, it is estimated that around 8 per cent less land will be farmed under these reforms than under the baseline situation. However, some regions, areas and farm types face more significant reductions. The reforms are particularly felt on livestock grazing farms situated in the more marginal areas of Europe, which also coincide with areas of high nature value. Therefore, farmland biodiversity is likely to be reduced in these areas. However, using a range of environmental indicators, relating to nutrient surpluses, GHG emissions, soil erosion and species abundance, an overall improvement in the environmental footprint of agriculture is likely. In addition, the economic efficiency of the agricultural sector will probably improve. The paper considers several possible options available to deal with any negative aspects of land abandonment. Following the FAO (2006), it is argued that untargeted, rather general agricultural policy measures which maintain land in production are likely to be an ineffective and inefficient way to address the perceived negative consequences of abandonment. A more holistic approach to rural development is required, tailored to the specific context within each area.

Keywords Agricultural Policy, Land Use Change, Land Abandonment

Policy Reform and Agricultural Land Abandonment in the EU

Introduction

Various concerns have been raised that reductions in EU support to agriculture and reforms of trade policy will lead to widespread land abandonment across the EU with negative environmental and social consequences. In fact, this case was made strongly during the 2003 reform process where, as noted by the European Commission,¹ some Member States considered that full decoupling of support from production could lead to several risks such as the abandonment of production, the lack of raw material supply for processing industries, or to social and environmental problems in areas with few economic alternatives. For this reason the Single Payment Scheme included a significant degree of national discretion in implementation (including the use of Article 69²), that allowed member states to retain some elements of the former coupled direct payments either in part or in their entirety.

Land abandonment is a complex multi-dimensional process with interlinked economic, environmental, social aspects. Therefore, much of the political significance of change in land use derives from local context. Understanding the potential scale of this ‘problem’ is therefore important to decisions on the future of agricultural and trade policy.

The purpose of this paper is twofold: (i) to examine whether or not the proposition that agricultural and trade reform will lead to widespread land abandonment across Europe is realistic and; (ii) to assess the wider environmental consequences of possible reforms. In addition the implications for policy arising from the process of land abandonment are also considered. To achieve these aims, the paper is the first to use a modified version of the CAPRI model (modified to include a regional land supply model parameterized based inter alia on Dyna-Clue) that is able to both capture the nuances of agricultural support and also simulate the movement of land in and out of agricultural use.

Background

Land abandonment has long been a contentious issue within Europe (for example see Pointereau *et al* 2008; Brouwer *et al* 1997; Baudry 1991). In part, as noted by Keenleyside and Tucker (2010) and others, this is because it has proved difficult to define, measure and study. For example, Moravec and Zemeckis (2007) note that there is no single definition of the terms “land abandonment” or “abandoned land”, with different interpretations between each legal or scientific text. The lack of consistent measurement across the EU means the current extent of abandonment is not known (Pointereau *et al*, 2008). However, whilst the exact extent may not be documented, it is clear that substantial areas of the EU have been affected by agricultural abandonment, however defined. This is largely a result of declines in the viability of extensive (low input) and small-scale agriculture systems (Baudry, 1991; Pinto Correia, 1993).

¹ See CAP Health Check proposals http://ec.europa.eu/agriculture/healthcheck/prop_en.pdf

² Article 69 of Council Regulation (EC) No 1782/2003. This Regulation established the legal framework for the Single Payment Scheme. Article 69 allowed for up to 10% of single payment ceilings to be effectively re-coupled and used to subsidise ‘specific types of farming which are important for the protection or enhancement of the environment, or for improving the quality and marketing of agricultural products’.

As summarised by the FAO, the reasons for abandonment of land are multidimensional and can be differentiated as follows: natural constraints, land degradation, socio-economic factors, demographic structure, and institutional framework (FAO, 2006, p2). Whatever the cause, abandonment is of concern to policy makers and others because of its negative social, economic and environmental associations (Moravec and Zemeckis, 2007). For example, in southern Europe a major environmental concern is the fire risk associated with abandoned land (Moravec and Zemeckis). In more northern parts of Europe, loss of farmland biodiversity is seen as a key environmental concern (see for example Baudry, 1991). More broadly, land abandonment is intimately linked with the wider issue of rural depopulation, whereas in Eastern Europe, widespread abandonment was associated with the transition process (Keenleyside *et al* 2005).

Whilst land abandonment is often viewed negatively, it is not always clear that land abandonment is detrimental. For example, in term of nature conservation, Keenleyside and Tucker note:

‘In many circumstances abandonment may be damaging as it will threaten a range of semi-natural habitats and associated species of nature conservation importance, many of which are concentrated in Natura 2000 sites and other High Nature Value (HNV) farmland. But in some locations abandonment could be highly beneficial, particularly in highly fragmented landscapes and where it could provide the opportunity for significant large-scale restoration of non-agricultural habitats (eg re-wilding).’ (Keenleyside and Tucker 2010 p1)

As noted within the introduction, there is a fear that agricultural and trade reform will reduce the economic viability of farming in Europe and lead to further abandonment of the more marginal agricultural areas. A number of studies have attempted to analyse the issue of land use under a range of future scenarios. Examples include: Scenar I and II; EURURALIS (Verburg *et al*, 2010); FP6 SENSOR (Helming *et al*, 2011) and; Land Use Modelling Implementation (Pérez-Soba *et al*, 2010). Jansson *et al* (forthcoming) provide an overview of the approaches adopted whilst Keenleyside and Tucker (2010) note that the scenarios typically vary according to two key axes: the degree of globalisation and the degree of regulation. As part of a useful synthesis of these modelling exercises they found that:

- The results of these recent modelling studies suggest that there is likely to be significant levels of farmland abandonment in Europe over the next 20 to 30 years.
- In general, the highest projected levels of abandonment are simulated for scenarios that anticipate high levels of global competition in agriculture, and low levels of CAP support for extensive farming. However, still significant abandonment is also projected under scenarios with reduced global competitiveness, high levels of support for agriculture and the environment and strong regulations.
- Abandonment projections appear to be considerably reduced in scenarios that incorporate high levels of biofuel production in the EU.
- The studies are generally consistent in identifying regions most at risk from abandonment. These will be in Finland and Sweden, the Pyrenees, north-western Spain and Portugal, the Massif Central (France), Apennines (Italy), Alps, other uplands areas of Germany and the border area of the Czech Republic and, to a lesser extent, the Carpathian Mountains. Most of these areas are mountainous, hilly or in northern latitudes and are likely to include a large proportion of HNV farmland.

Existing model projections are constrained by available data, and uncertainty over future socioeconomic developments and policy decisions. The models are also deterministic and assume that land owners take decisions primarily on the basis of economic signals with little time lag. In reality it is evident that landowners will often continue uneconomic farming (by supplementing incomes in others way) for a variety of social and cultural reasons (Renwick and Revoredo-Giha, 2008). On the other hand, some factors not directly included in the scenarios may result in underestimation of abandonment such as the effects of ongoing soil erosion, rural depopulation and climate change.

In the past, a particular weakness of the CAPRI framework for considering land use change was that it was unable to account for land moving in and out of agriculture or transforming between arable and crops. This paper undertakes a new and consistent analysis of the impact of reform on land use using an innovative modification to the CAPRI model to account for this key limitation and this is discussed in the next section.

Methods

In view of the issues and challenges in quantifying the possible impacts on land-use, the use of a well established EU wide modelling framework capable of capturing the complexities of the implementation of alternative policies at the regional level was deemed the most appropriate approach. Therefore, a modelling chain consisting of the CAPRI and the Dyna-CLUE models was selected.

The CAPRI model has been extensively employed in applied policy impact analyses in the EU as it links a regionalized agricultural supply model with detailed production technology and a world trade model for agricultural and food commodities.³ However, for the purposes of this study the Dyna-CLUE is also required to help overcome two key constraints of the CAPRI model in relation to studying the local impacts of land abandonment. The first relates to the fact that the CAPRI model treated land-use as fixed and the second is that the spatial aggregation to NUTS2 regions within the model is too great for the requirements of a study on the impacts of land abandonment, given that these are often very location specific.

Therefore, the simulation of land use change and associated impacts is based on the use of multiple models to address the different scales of analysis and multiple inputs (Hellmann and Verburg, in press; Verburg et al., 2008). The main external driving factors that are specified as inputs to the models are demography, overall economic development (GDP), technological change and government policies. Economic and policy changes and interactions with regions outside Europe are simulated using the CAPRI model with output at the level of NUTS2 administrative level. Within Europe a more detailed assessment is made of the spatial patterns of land use change in order to identify which regions are expected to face specific land use change processes. A spatially explicit land allocation model, CLUE (Conversion of Land Use and its Effects, Dyna-CLUE version (Overmars *et al.*, 2007; Verburg and Overmars, 2009) was used with a spatial resolution of 1 km² for yearly time steps. Seventeen different land use types are distinguished based on the CLC2000/CORINE land cover database (EEA, 2005; Haines-Young and Weber, 2006) including built-up area, rainfed arable land, pasture, (semi-) natural vegetation, inland wetlands, irrigated arable land, recently abandoned farmland, biofuel crops, permanent crops, forest, and a number of different distinct (semi-) natural land use types such as beaches, glaciers, etc.

³ The project website www.capri-model.org provides an updated list of the applications of CAPRI

The CLUE model is based on the dynamic simulation of competition between land uses while the spatial allocation rules are based on a combination of empirical analysis of current land use patterns (Verburg et al., 2006a; Wassenaar et al., 2006), neighborhood characteristics (Verburg et al., 2004a), and scenario specific decision rules. The spatial allocation rules are configured separately for each country to account for the country-specific context and land use preferences. The land requirements for the different land use types to be allocated by the model are specified at the national scale for each country within Europe separately as follows:

- Growth in built-up area is based on demographic development, immigration ratios and scenario-specific estimates of change in area used per person
- Changes in natural vegetation are the result of both net changes in agricultural and built-up area and locally determined processes of re-growth of natural vegetation (Verburg and Overmars, 2009). After abandonment of agricultural land re-growth of natural vegetation is determined by the local growing conditions (soil and climate conditions), population and grazing pressure and management. The possibilities to convert natural vegetation into agricultural land or residential/industrial land depend on the location and the type of natural area. Path-dependent dynamics arise from the combination of top-down allocation of agricultural and urban demand and bottom-up simulation of the (re-) growth of natural vegetation.

CAPRI models agricultural production as a constrained non-linear mathematical programming model in each of 232 regional representative farms in the European Union, Norway, Western Balkans and Turkey. In each region, the farmer is modelled as maximizing the sum of gross value added plus premium plus an econometrically estimated non-linear behavioural term (Jansson & Heckeley, 2010) subject to exogenous prices, premiums and a set of constraints. The constraints involve fertilization, feeding, set-aside, input-output relations, and, until recently and of particular interest here, fixed amounts of arable land and grassland. The regional supply models are linked with: a global multi-commodity trade model that determines the prices of agricultural goods; a young animal trade model that computes equilibrium prices of young animals for the regional models and; a premium module that computes the premium payment rates with consideration of the budgetary and other restrictions provided by the various regulations.

Prior to this project, the model assumed that total land area was fixed as was the quantity allocated to arable crops and permanent grass lands. This paper expands the existing CAPRI model by introducing behavioural functions for agricultural land supply and the transformation between arable land and grass land. The idea is that we can thereby combine the detailed regionalization of agricultural policies and production technology of CAPRI with estimates of land supply behaviour to estimate impacts on regional land use. The process of modifying the model is reported in detail within Jansson *et al* (forthcoming).

Indicator models

To aid analysis of the possible environmental impacts of reform of agricultural and trade policies, a number of indicators are calculated based on the spatial modeling results.

- i) A land abandonment indicator summarizes the high-resolution results by areas of concentrated abandonment. The indicator summarizes the amount of land abandoned within the immediate neighbourhood (approximately 25 km²).
- ii) A biodiversity indicator is derived based on the GLOBIO approach (Alkemade et al., 2009; Verboom et al., 2007) modified for the European context and accounts of different pressures on biodiversity. More specifically the indicator is a measure of the relative mean species abundance (MSA) where the original abundance is discounted for land use intensity, fragmentation, roads, protection status and nitrogen deposition levels. A detailed description of the indicator can be found in Eickhout and Prins (2008). It should be noted that the approach by which the biodiversity indicator is calculated is biased towards species abundance in (semi-)natural ecosystems; agro-biodiversity is therefore not strongly accounted for. This needs to be accounted for in the interpretation of the results (Temme and Verburg, 2010)
- iii) An index of erosion is used as a measure of sustainable management of natural resources. The index is based on a European version of a common approach to estimate erosion (Universal Soil Loss Equation) accounting for land use, soil, terrain and climate conditions. A detailed description can be found in Perez Soba et al. (2010).

Baseline and Scenarios

Three future scenarios are examined and compared to a baseline situation. The baseline assumes that the CAP “Health Check” reform is implemented and that the resulting policies continue up to 2020. In particular: milk quotas are abolished; sugar quotas after the reform are kept in place; there is no compulsory set-aside and; direct payments are further decoupled. Of the formerly coupled payments of the first pillar, only the following remain coupled in the baseline (to the extent that each member state has utilised the coupling option): Suckler cow premiums; direct payments for sheep and goats and; various payments to fruits and vegetables and wine.⁴ The three scenarios considered within the study are:

- Scenario 1 (No Pillar 1) consists of the removal of all Pillar 1 payments, coupled or decoupled, and all market support measures across the EU
- Scenario 2 (WTO) assumes an agreement is reached through the WTO on trade liberalisation
- Scenario 3 (Liberalisation) combines Scenario 1 and Scenario 2

In effect, Scenario 2 is based on proposals made by the chair of the WTO's agriculture negotiations, Ambassador Crawford Falconer (WTO, 2008). Whereas some aspects of the proposal can be directly incorporated (for example timing and extent of tariff reductions) others require further assumptions to be made. In particular, this relates to the issue of choice of sensitive products and how they will be treated. For this analysis, the following were considered as sensitive products for the developed countries: beef, poultry, pork, dairy (cheese and butter), sugar, some fruit and vegetables and ethanol. It was assumed that these products take a tariff cut two-thirds less than that implied by the tiered formula, and that their TRQ is increased by 4 per cent of consumption (based on a three year average of 2003-2005). Their in-quota tariffs were either cut by 50 per cent, or set at 10 per cent ad valorem equivalent (AVE), whichever resulted in the lower tariff (and in-quota tariffs that are currently less than or equal to 5 per cent AVE were reduced to zero). The exception to this

⁴ Further information on the development of baselines in CAPRI can be found at <http://www.capri-model.org/refrun.htm>

rule was ethanol, where there was currently no quota and for which consumption in the reference period (2003-05) was significantly lower than it is now. Therefore in ethanol's case 10 per cent of 2008 consumption was considered a reasonable approximation.

Seven countries were identified for more detailed analysis (Germany, Greece, Spain, France, Poland, Hungary and the UK). These countries were chosen to reflect the diversity of agricultural and institutional structures across the EU.

Results

Introduction

To place the results in context, the impact of the reforms on overall prices and production levels of key commodities within the EU are reported. The analysis then proceeds to consider changes in land-use by country, by farm type and by region. Following this, changes in key environmental indicators are considered. The final stage highlights the results from the process of spatially disaggregating the results across the EU.

Prices and Production

The estimated impacts on overall levels of production within the EU of the agricultural and trade reforms captured in the three scenarios are, in the main, relatively small (Table 1). Given the concern expressed over the potentially detrimental effects arising from the removal of Pillar 1 payments and trade liberalisation on EU agriculture, it might seem surprising that the reforms are predicted to have such a relatively small impact at the aggregate level. However, the initial shock of reform appears to lead to a process of market adjustment that mitigates the overall impact. In addition, the fact that key commodities (beef, dairy products etc.) have been included as sensitive products subject to reduced tariff cuts, dampens the impact of trade reform on EU agriculture. The results are also consistent with earlier work, for example Philippidis *et al* (2007) using the GTAP model, found relatively small price and production changes at the EU level for many commodities under various trade and CAP reform scenarios.

Table 1 Impact of Scenarios on EU prices and production of key agricultural commodities+ (EU27)

Product	Price			Production		
	S1 No Pillar 1	S2 WTO	S3 Liberali sation	S1 No Pillar 1	S2 WTO	S3 Liberali sation
	Per cent					
Cereals	9.90	-0.48	7.61	-1.18	-0.31	-3.28
Oilseeds	6.29	0.26	6.47	-7.14	-0.52	-7.26
Other arable field crops	1.64	-1.57	0.13	0.24	0.08	-0.76
Vegetables and Permanent crops	0.41	0.13	0.50	-0.03	0.02	-0.01
Meat	2.50	-4.70	-2.40	-1.16	-1.13	-2.27
Other Animal products	2.35	2.40	4.47	-0.85	1.65	1.00
Dairy products	-0.94	-1.33	-2.03	-0.15	-1.98	-2.07
Oils	2.13	-0.80	1.23	-0.33	-1.39	-1.72

Notes + All figures shown are percentage differences from the baseline situation

Though overall production levels remain fairly stable under the reform scenarios, there are more noticeable changes in terms of land use and livestock numbers both at the EU and individual country level. Shifts in the relative profitability of enterprises lead to quite marked shifts in land-use as a result of Pillar 1 reform (Table 2). For example, under S1, pasture declines by just over 10 per cent in the EU27 and arable by over 6 per cent. The level of decline is greater in the EU10 at 13 and 8 per cent for pasture and arable, respectively. Trade liberalisation (S2) in itself appears to have relatively little impact on land-use. This suggests that the Pillar 1 payments and the associated commitments in terms of cross-compliance and the “Good Agricultural and Ecological Condition” (GAEC) maintain land in use. For the EU27 as a whole, the area utilised for agriculture (UAA) declines by around 8 per cent under the CAP reform scenarios when compared to the baseline. The combination of agricultural and trade reform (S3) leads to the most significant changes in land use.

Although all countries studied witness a decline under S1 in land utilised for pasture and arable, the extent of the decline varies quite markedly as does the balance of the decline between the two categories. Greece, for example, is predicted a significant fall in both pasture and arable (16 and 13 per cent, respectively) whilst Spain has a much greater reduction in pasture than arable land (13 per cent compared with 3). The variation across EU countries may reflect the extent that specialisation has occurred in the agricultural sector. For example, in the UK where a high degree of specialisation has happened, arable land falls by a small percentage. This may be because arable production is already situated on the most suitable land. However, in countries such as Germany, where mixed farming is more prevalent, arable production is probably still occurring in more marginal areas. The low reduction in arable land in Spain reflects a specialisation in permanent crops which have a higher labour and capital input.

Table 2 Changes in Pasture, Arable and UAA by EU Group and Selected Countries+

	S1 (No Pillar 1)			S2 (WTO)			S3 (Liberalisation)		
	Pasture	Arable	UAA	Pasture	Arable	UAA	Pasture	Arable	UAA
EU27	-10.44	-6.45	-7.82	-0.12	-0.19	-0.16	-10.72	-7.06	-8.32
EU25	-10.15	-6.50	-7.76	-0.11	-0.19	-0.16	-10.42	-7.15	-8.28
EU15	-9.69	-6.03	-7.40	-0.12	-0.24	-0.19	-10.00	-6.76	-7.97
EU10	-13.19	-8.03	-9.20	-0.04	-0.04	-0.04	-13.25	-8.45	-9.54
Germany	-8.50	-8.64	-8.60	-0.08	-0.60	-0.46	-8.77	-9.71	-9.46
France	-8.36	-6.35	-7.02	-0.08	-0.24	-0.19	-8.59	-7.07	-7.58
Spain	-13.44	-3.00	-6.76	-0.16	-0.10	-0.12	-13.65	-3.72	-7.29
Greece	-15.56	-13.33	-14.07	-0.06	-0.09	-0.08	-15.70	-13.95	-14.53
United Kingdom	-8.72	-2.61	-6.44	-0.25	-0.03	-0.17	-9.52	-3.20	-7.16
Hungary	-18.40	-5.55	-7.65	-0.06	-0.03	-0.04	-18.23	-6.12	-8.10
Poland	-13.28	-9.58	-10.31	0.01	-0.06	-0.05	-13.31	-9.98	-10.63

Notes + All figures shown are percentage differences from the baseline situation

Table 2 also presents the overall impact of these changes in terms of utilised agricultural area under the three scenarios. When the figures are disaggregated by country the extent of the fall in farmed area varies from just over 7 per cent for the UK up to over 14 percent for Greece under S3. Further disaggregating the results by region, we begin to see the spatial nature of the results for the seven countries under consideration. Table 3 highlights those regions where a 10 per cent or greater reduction in UAA is estimated. The results appear to

follow existing work as to areas currently under threat of land abandonment (as reviewed in Keenleyside and Tucker, 2010 and Pointereau *et al*, 2008). These include the more mountainous regions of France and Germany, areas of Spain and Poland. Greece appears to be particularly affected by the reforms, with five of the six regions forecast to have a reduction in agricultural area of over 20 per cent located in the Country. The impact on overall land use appears to be determined by the profitability of particular enterprises and the suitability of the land for alternative uses.

Table 3 Regions within Selected EU Countries with estimated reductions in UAA of over 10, 15 and 20 per cent

Country	Region
10 to <15 per cent	
Germany	Braunschweig, Freiburg, Unterfranken, Thuringen, Oberbayern, Duesseldorf, Muenster, Oberfranken, Arnsberg, Oberpfalz
France	Champagne-Ardenne, Lorraine, Bretagne, Alsace
Poland	Pomorskie, Lubelskie, Lubuskie, Podlaskie, Zachodniopomorskie, Swietokrzyskie, Warminsko-Mazurskie, Podkarpackie
Greece	Ionia nisia, Sterea ellada
Hungary	Közép-Magyarország
15 to <20 per cent	
Hungary	Észak-Magyarország
Germany	Saarland, Niederbayern
Spain	Pais vasco, Galicia, Cantabria
Greece	Voreio aigaio, Ipeiros
Poland	Slaskie, Malopolskie
20 and above	
Greece	Kriti, Peloponnisos, Dytiki ellada, Attiki, Notio aigaio
Spain	Asturias

Notes + All figures shown are percentage differences from the baseline situation

Analysing the figures by farm type and by farm size using CAPRI's farm type layer (Gocht & Britz, 2011) gives further insight into the impacts of the reforms (Table 4). In the majority of countries, as might be expected, it is the grazing livestock categories (for example sheep and goats) where UAA falls most significantly (around 25 per cent). Interestingly this is not the case for France where specialist fruit and dairying are most affected. In general, a greater proportion of land on smaller holdings (as measured by economic size unit), appears to become idle under the reforms. Again, France appears to be an outlier, perhaps reflecting that it is in the more intensive sectors of dairying and fruit production that the reduction in UAA is the greatest.

Table 4 Change in Utilised Agricultural Area by Farm Type and by Farm Size under Pillar 1 removal

Farm Type/Size	EU27	Spain	Greece	Germany	France	Hungary	Poland	UK
Specialist cereals, oilseed and proteins	-11.5	-6.2	-11.2	-6.7	-8.2	-8.0	-9.6	-1.8
General field/mixed cropping	-11.8	-5.2	-15.2	-7.1	-7.2	-7.0	-10.3	-1.2
Specialist cattle-rearing and fattening	-14.1	-11.0	..	-13.8	-5.1		-12.6	-10.0
Sheep, goats and other grazing livestock	-25.2	-13.7	-16.0	-25.2	-6.7	-13.2	-15.5	-10.8
Specialist horticulture	-1.0	-0.4	..	..	..	..	..	..
Specialist vineyards	-2.5	-0.9	..	-1.3	-2.2	..	..	..
Specialist fruit and citrus fruit	-2.1	-0.9	..	..	-9.9	..	..	..
Mixed crops-livestock	-11.3	-8.3	-15.3	-8.4	-7.9	-6.0	-9.8	-2.9
Specialist dairying	-12.6	-12.5	..	-10.3	-9.3	-5.7	-13.1	-3.4
Specialist granivores	-11.4	-3.7	-3.1	-13.6	-8.3	-14.3	-6.5	-2.4
Mixed livestock holdings	-12.9	-9.2	-18.3	-9.8	-8.4	-7.1	-10.0	..
Various permanent crops combined	-15.8	-2.8	-12.1	..	..	..	..	..
Specialist olives	-19.7	-6.6	-17.4	..	..	..	..	..
Other farm types (aggregated)	-	-7.7	-10.3	-9.2	-4.9	-7.5	-11.3	-3.3
By Size								
< 16 ESU	-17.0	-8.2	-16.3	-15.0	-4.9	-7.3	-10.8	-9.2
> 16 < 100 ESU	-14.4	-5.7	-12.9	-10.1	-7.3	-8.0	-7.4	-9.4
>100	-9.7	-5.1	0.0	-6.5	-8.1	-7.8	-7.4	-3.2

Notes + All figures shown are percentage differences from the baseline situation

Changes in land-cover are important when considering the environmental implications of the proposed reforms, but clearly the intensity that the land is utilised is also important. Some indication of this can be derived from the CAPRI model which provides information on livestock numbers.

Dairy and beef based on dairy calves are only marginally hit by the reforms captured in S1 (under one per cent for dairy and around two per cent for beef production). More marked declines are witnessed in suckler cow production with a predicted fall of just over 12 per cent (ranging from a negligible change in Germany to a 23 per cent reduction in Greece). The variation in the impact on suckler cow numbers across countries may also be related to the way in which the 2003 reforms were implemented. For example (with the exception of the Scottish Beef Calf Scheme) the UK fully decoupled all payments including those to livestock. France and Spain did not fully decouple. Therefore, they are effectively moving from a situation where production was still partially coupled and a greater level of adjustment might be expected.

Sheep and goat numbers also decline under the reforms, again also an effect of remaining coupled support then removed in the scenarios, with both CAP reform and trade liberalisation leading to lower numbers. When the reforms are combined under S3, falls of between five and six per cent are predicted. The impact is greater in the old rather than new member states.

Overall, the change in utilised area does appear quite marked when compared to the estimated changes in production and livestock numbers. This infers that it is the more

marginal areas (least productive) where production is ceasing and that idling, non-productive land kept in GAEC and drawing decoupled support is abandoned. It also suggests that farmers at the intensive margin are responding to the price changes associated with CAP reform and increasing production. Together, these two factors point to the reform improving the overall efficiency of production across the EU27.

Environmental Indicators

The CAPRI model provides also indicators of the environmental pressures arising from agriculture, namely changes in nutrient surpluses (nitrate, phosphate and potassium) and gas emissions (ammonia, methane and nitrous oxide).⁵ The decline in utilised area coupled with smaller livestock numbers and changed cropping patterns leads to a fall of around 4 (5) per cent for potassium and phosphate and just over 2 (3.5) per cent for nitrate surpluses under S1 (S3). The smaller impact of trade liberalisation (S2) on agricultural production is reflected in smaller changes. On a per utilised hectare basis, there is actually a general increase in nutrient surpluses (the exception being nitrates under S2). This may add support to the hypothesis that some intensification is occurring on the land remaining in production. However, it is more likely that this is an artefact of the use of weighted averages. That is as the marginal less intensive areas cease production then the average nutrient use on the land remaining in production will increase.

Although for the EU as whole nutrient surpluses are predicted to fall under all the reform scenarios, the picture is not quite so clear cut at the country level. Nitrate and Phosphate surpluses decline for all countries under Scenario 1. This is most marked for nitrates in Germany and Poland (with declines of over 8 per cent) and for phosphate in Spain and Poland (falling by 6 and 8 per cent, respectively). Further examination highlights that this reflects changes in cropping patterns (for example Germany and Poland have the largest reduction in cereal area as a result of the reforms) as well as land leaving production. Potassium surpluses increase significantly for Hungary and Germany (and marginally in UK) with the removal of Pillar 1. Similar to the EU analysis above, Scenario 2 leads to smaller changes in overall surpluses.

The reduction in livestock numbers and areas cultivated leads to reductions in the key gaseous emissions from agriculture. For example under Scenario 3, ammonium output falls by around 3 per cent, methane by around 4 per cent and nitrous oxide by around 5 per cent across the EU27. At the country level, the pattern highlighted for nutrient surpluses is reflected in the predicted changes in GHG emissions. For example, Germany and Poland have the largest reduction in Nitrous Oxide emissions under Scenario 1 (of around 6 per cent) reflecting the changed patterns of land-use.

Spatial Analysis

The CLUE model results in yearly maps of the land use pattern for the period up to 2020. While land abandonment is limited in the reference scenario and WTO scenario, extensive areas of land abandonment are observed in the other two scenarios. The results are summarized below for the process of land abandonment under Scenario 3, indicating hot-spots of land abandonment (Figure 1). Corresponding to the CAPRI results these areas of land abandonment are mainly found in the mountain regions of Europe. However, the spatial detail of the CLUE simulations reveals that within mountain regions variation exists.

⁵ Details of how these are calculated can be found at www.capri-model.org

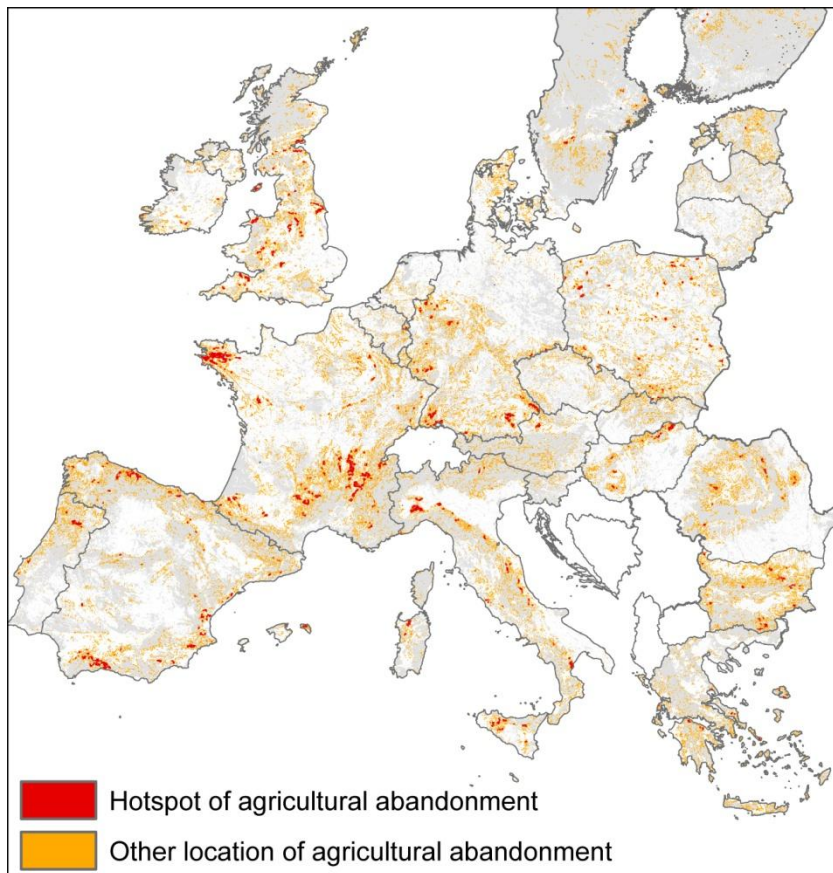
While agricultural land use remains in the valleys and the plateau areas of some regions, the steeper slopes are abandoned. This form of abandonment has been an ongoing process.

In the dry Mediterranean climates, shrubland is in some cases the climax vegetation. Succession may further be slowed down by irregular grazing of goats and sheep that is common in many of the southern areas facing land abandonment. However, although accounted for to some extent in the model simulations, it is less likely that remote areas are irregularly grazed given the labour intensity of such livestock management systems.

Biodiversity change overlaps to a large extent (though not completely) with the patterns of agricultural abandonment. In most cases, areas with high abandonment rates report significant increases in the Mean Species Abundance index. At this stage it is useful to reiterate what the index shows. The MSA is an index for the biodiversity level of a location based on discounting the undisturbed level of biodiversity (where $MSA=1$) for influences due to land use change, fragmentation etc. In particular, the index is highly sensitive to fragmentation and ecosystem type. This means that (semi-) natural land covers normally have higher species abundance. In addition, land abandonment often reduces the fragmentation of the natural ecosystems raising the MSA. Therefore a strong correlation between MSA and land abandonment might be expected. Past abandonment in a number of mountain regions has already resulted in increased viability of habitats for a number of species that require relatively large undisturbed areas (e.g. bears, bison and wolves in the Carpathians (Kuemerle et al., 2010). However, at the same time (dry) mountain grasslands are considered to have high biological diversity as well and add to the overall diversity of the agro-ecosystem in these regions (Bolliger et al., in press).. Land abandonment mostly leads to a loss of such systems. Therefore, commonly a tradeoff between the diversity of (semi-) natural ecosystems and agro-ecosystems is observed upon land abandonment with diverging opinions on its benefits to society and the ecosystem as a whole. The loss of diversity in mountain landscapes also has drawbacks for other ecosystem services provided in these areas such as protection of the cultural heritage and landscape esthetics that attract tourists.

At the same time some decreases in biodiversity index are observed mainly related to further urbanization, which leads to drastic decreases in biodiversity value and fragmentation of habitats.

Figure 1 Projected Areas of Land Abandonment under Scenario 3



Note: Red Areas represent Hotspots of Abandonment whilst Yellow represent concentrated areas of abandonment

The erosion index exhibits a similar pattern as the MSA and abandonment. However, in this case the changes match closely with the areas of high erosion sensitivity: the steep mountain regions especially in Southern Europe that face strong, irregular, rainfall events. When the most sensitive locations for erosion overlap mostly with the least profitable locations for agricultural production, land abandonment results in a more than proportional improvement in soil sustainability. It is though worth noting that in the baseline and WTO scenarios, that show relatively little net abandonment, a major improvement in soil sustainability is achieved. This is the result of continuing land abandonment at the most marginal locations and concentration of agricultural practices in the more favourable regions such as the valleys. These relatively small changes and rearrangements of farming practices do have a major influence on the erosion indicator.

Discussion

On the one hand, the results of the modeling exercise show only moderate impacts of agricultural and trade reforms on EU agriculture. Overall production levels are unlikely to change markedly and the proportion of land potentially leaving agriculture is relatively small. In addition, there appear to be potential economic (efficiency) and environmental gains (lower overall greenhouse gas emissions, reduced nutrient surpluses) to be had from wider reforms of agricultural and trade policy. Further, there are potential environmental benefits

arising from the process of abandonment itself (such as improvements in non-farm biodiversity and reduced erosion).

On the other hand, whilst production is not markedly changed, overall GVA is predicted to fall by around 20 per cent in the EU27 (and by a higher percentage in the new member states), asking for sizable farm structural change to maintain current economic returns to primary factors in agriculture. In addition, although overall nutrient surpluses decline, the reduction does not generally occur in intensive areas with high per hectare surplus. The bias in the biodiversity indicator (MSA) towards (semi) natural biodiversity rather than farmland biodiversity also needs to be taken into account. The predicted cessation of farming in many high nature value areas is likely to lead to a loss in farmland biodiversity. This is due to the fact that the reforms are predicted to hit the more extensive forms of agriculture (grazing beef and sheep) with significant areas on these farms predicted to go out of production. These systems are intimately linked with the maintenance of farmland biodiversity. Though not conclusive the results also hint at other changes in land-use that might be detrimental to biodiversity. It appears that arable production will decline markedly in areas that have been traditionally mixed (for example in parts of Germany). As McCracken and Klockenberg (1996) note, scientists are generally agreed that mixed farms are important for supporting farmland biodiversity and therefore a process of specialisation may reduce overall biodiversity in these areas.

An important question is to what extent models are able to truly capture the complex processes that lead to land-use change and ultimately land abandonment (Keenleyside and Tucker, 2010). As the model results are largely based on a comparison of the farming conditions in marginal areas and other regions, they may underestimate the extent of abandonment in marginal areas because it ignores the changing demographic situation in many of these regions. The fact that the farmer population is aging and coupled with a shortage of successors suggests that many of these regions will have higher rates of land abandonment in the future. However, Keenleyside and Tucker (2010) put forward a counter argument stating that ‘the models may be overly deterministic, as they do not take into account social and cultural factors that may encourage the continuation of uneconomic farming activities, such as use of the land for recreation, and the desire to continue cultural or family traditions and stay in the community.’ (Keenleyside and Tucker 2010 p72). They also argue that some areas that are stated as being abandoned may in fact be areas that are subject to very low levels of management (and may therefore be only semi-abandoned) or be areas that are planted with trees (eg under afforestation programmes) and under active management. What is unknown is the extent to which these omitted factors cancel each other out, though Keenleyside and Tucker argue that they are likely to balance out to some extent.

A further important factor is the extent that the reforms initiate a process of structural change within agriculture which could lead to efficiency gains and less land moving out of agriculture. Brouwer *et al* provide a useful illustration of the contextual nature of abandonment ‘Similarly, a farm which is abandoned by an aging farmer in southern Portugal may be converted into a highly competitive holding by a young Dutch incomer with the necessary resources’. Brouwer *et al* (p11). Structural change is important for a number of reasons. First, changes in the number of farms may be seen as an indicator of the social impact of reforms particularly in remote rural areas. Second, if through the process of structural change more efficient farms take over less efficient farms then overall efficiency of the sector may improve. This can improve the competitiveness of the sector, reducing dependency on support and also mitigate the negative impacts of reform. However, as noted

by Heckeley (2010) capturing the process of structural change has proved very challenging for the modeling community.

Whether or not the model estimates are conservative, land abandonment is likely to be an important factor in specific areas of Europe and for particular types of farming. In addition available evidence also highlights that abandonment itself can have a wide range of implications both positive and negative. Therefore as the FAO (2006) note this is likely to call for some form of policy response. The nature of this response will vary across regions as the reasons for abandonment can be differentiated as follows: natural constraints, land degradation, socio-economic factors, demographic structure, and institutional framework (FAO, 2006, p2).

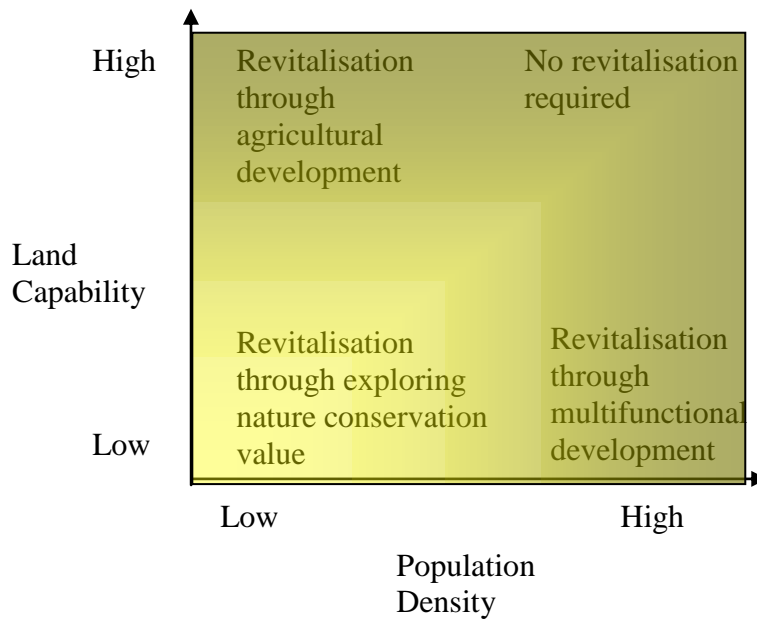
The simplest approach may be to consider the proportion of the current levels of Pillar 1 support that would be needed to maintain production in the areas identified as ceasing production because of the reforms. Simple analysis highlights that only a small proportion would be required, around 7 per cent for the EU27 as a whole. Although this estimate is based on the restrictive assumptions that payments can be targeted only at the areas which go out of production and any potential producer surplus is captured in the payment process (ie potentially through some auction process). Therefore, the example is really for illustrative purposes and should be interpreted only as the minimum possible proportion required. However, it does highlight the principle that Pillar 1 payments are an inefficient way to tackle the issue of land abandonment.

A more general question is whether the right approach is designing policies that maintain land in production. It may be argued that it is more efficient to have policies and payments aimed at ameliorating the negative environmental impacts of land abandonment rather than just maintaining land in production. Further, it may be argued that concentrating on agricultural support is the wrong way to look at the problem and that a broader approach needs to be taken to the issue of revitalising marginal areas. The FAO (2006) note that, taking into account the reasons for land abandonment and depopulation, there are different opportunities for intervention to revitalise areas with varying probabilities of success. For example they argue that:

- Natural constraints cannot be influenced but can only be compensated for.
- Degradation processes can sometimes be reversed through technical interventions.
- Demographic development can only be influenced to a limited extent and;
- Socio-economic factors and institutional frameworks can be addressed by appropriate policies, however, sometimes these generate undesired side effects (FAO, 2006, p12).

Figure 2 summarises the FAO view on how the problems of marginal areas may be tackled when considered in two dimensional space, relating to extent of land capability and population density.

Figure 2 Representation of FAO classification of approaches to revitalising marginal areas



However, this broader approach is clearly beyond agricultural policy. More directly, in terms of the future of the CAP, there are challenges in dealing with land abandonment. Whilst ‘greening’ the CAP and moving towards paying for public goods could in theory be a way to offset any negative effects of land abandonment, there are challenges in this approach. For example, the recent Pack inquiry in Scotland (SG, 2010) has advocated that those receiving support must maintain minimum stocking rates. However, forcing farms to have minimum stocking rates when production is unprofitable may mean their income will be lower than under full decoupling. There is also a very real danger that providing sufficient support to enable the least profitable producers to stay in production will prevent structural change from occurring and the industry could become fossilised in an uncompetitive state. It is this balance between maintaining production in areas where it is deemed environmentally important, but still enabling agriculture to become more efficient that is the key policy challenge.

Conclusion

This paper has investigated the impact of agricultural and trade reform on land-use across Europe focusing on the issue of land abandonment. Three reform scenarios were considered using a modified version of the CAPRI model which accounts for the movement of land in and out of agriculture as well as between enterprises (arable and permanent grasslands). The CAPRI model is linked to the Dyna-CLUE model framework to enable the spatial impacts of reforms to be assessed in greater resolution. The analysis has highlighted that the overall impact of agriculture and trade reform on production within the EU is likely to be relatively small, with around 8 per cent more land predicted to be unfarmed when compared with the baseline situation. However, a more disaggregated analysis highlights more significant declines in particular countries, regions and farm types.

The analysis has highlighted that there are potential economic (efficiency) and environmental gains (lower overall greenhouse gas emissions, reduced nutrient surpluses, reduced erosion etc) to be had from wider reforms of agricultural and trade policy. In addition, there are

potential environmental benefits arising from the process of abandonment itself. On the other hand, there is likely to be a loss of semi-natural farmland (the areas perhaps most at risk of abandonment) leading to a further decline in farmland biodiversity across Europe. For some countries, a process of specialisation in production and simplification of the landscape will also occur which is also detrimental from a farmland biodiversity perspective.

Following the arguments of the FAO (2006) it is argued that simply designing agricultural policy to maintain land in production is likely to be an ineffective and inefficient way to address the perceived negative consequences of abandonment. A more holistic approach to rural development is required tailored to the specific context within each area.

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