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Climate, energy and environmental policies in agriculture: Simulating likely farmer responses in Southwest Germany

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ABSTRACT

Agriculture in many industrialized countries is subject to a wide range of policy interventions that seek to achieve ambitious climate, energy and environment-related objectives. Increasing support for the generation of climate-friendly, renewable energy in agriculture, however, may lead to potential conflicts with agri-environmental policies aimed at land use extensification and landscape preservation. These potential trade-offs and inconsistencies in terms of policy implementation are not yet well understood, since conventional tools for agricultural economic assessment work on an aggregate regional level and do not fully capture the likely farmer responses when making a choice between investments in biogas production and participation in agri-environmental policy schemes.

We employed a farm-level model to analyze the reaction of a heterogeneous farming population in Southwest Germany to the incentives set by the German Renewable Energy Act (EEG), on the one hand, and the agri-environmental policy scheme MEKA, on the other. Our simulations indicate a potentially large decrease of MEKA participation due to biogas production supported under EEG. The success of the 2012 EEG revision in reducing the 'maizification' of agricultural landscapes will critically depend on the local demand for biogas excess heat. In any case, the EEG revision does not alleviate conflicts between the expansion of renewable energy and environmental considerations, but rather shifts priorities from the former to the later: the simulated reductions of maize areas are achieved by a considerable reduction in overall biogas production ("output effect"), and not by encouraging less maize-intensive feedstock mixes ("substitution effect").

Introduction

The last two decades have seen a shift of focus in agricultural policies from direct subsidization of agricultural production toward payments for public goods and services, environmentally-friendly production and greenhouse gas reduction. This shift addresses growing public concern for the externalities of food production, climate change and the conservation of traditional rural landscapes and farming systems. The motivation behind this development can, to a certain extent, be further attributed to the desire of policy makers to maintain a certain level of support for farming, and at the same time respond to the pressure to phase out coupled support arising in trade negotiations (Baylis et al., 2008; Harvey, 2003). In any case, the wide array of different policy objectives bears the danger that individual policy measures are narrowly targeted at one objective, while inadvertently counteracting another objective. This danger is even more prevalent if different political departments and scientific communities are targeting different objectives (Poe, 1997).

In order to reduce dependency on fossil fuels, reduce greenhouse gas emissions and – in some cases – create new markets for agricultural products, many countries have started promoting bioenergy and biofuel production. The Renewable Energy Directive of the European Union, the US Renewable Fuel Standard (RFS), or the National Alcohol Program (and its successors) and the National Program on Biodiesel Production and Usage (PNPB) in Brazil are only the most prominent examples (Sorda et al., 2010). As these policies have become more widespread, the focus of public debate has shifted from their positive effects for greenhouse gas mitigation and energy security toward undesired side effects through increased agricultural land prices and direct and indirect land use changes (Janda et al., 2012; Ziolkowska and Simon, 2011; Zilberman et al., 2014). On the one hand, including the emissions from direct and indirect land use change into the analysis

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leads to much lower GHG reduction potentials from bioenergies (Searchinger et al., 2008; Janda et al., 2012). On the other hand, these side effects may trigger serious environmental implications. In Brazil for example, increased biofuel production from sugarcane and soybean led to high deforestation rates and a loss of biodiversity through mono-cropping and the expansion of agricultural lands (Timilsina and Shrestha, 2010), while in the US a considerable amount of grassland was converted to cropland leading to more soil erosion, higher fertilizer uses and increased carbon dioxide releases (Hertel et al., 2010; Wright, 2013). Contributing to topsoil loss, grass- and wetland conversion, and water pollution and threatening biodiversity the Renewable Fuel Standard produces exactly the negative environmental externalities of agriculture that other federal agri-environmental policy programs such as the Conservation Reserve Program, the Conservation Security Program, the Grassland Reserve Program, the Wetlands Reserve Program, the Wildlife Habitat Incentives Program, or the Environmental Quality Incentives Program as well as many state-level initiatives intend to reduce (Baylis et al., 2008).

Similar conflicts can be expected to arise between the ambitious renewable energy targets set forth by the European Union and their members states (Klessmann et al., 2011) and the environmental and social objectives promoted by the second pillar of the EU Common Agricultural Policy (CAP). As a specific example, we analyze the side effects of the expansion of biogas production under the German Renewable Energy Act ('Erneuerbare-Energien-Gesetz', EEG) in this article. Intended to contribute to greenhouse gas mitigation, this package of various policy instruments has both triggered an intensification of agricultural land use – which has been labeled a "maizification" of German agriculture – and farmer complaints of excessive land rental prices. This recent land-use change is at odds with the objectives of the agri-environmental measures under the second pillar of the EU CAP, which promotes the reduction of chemical input use, conservation of biodiversity and upkeep of traditional agricultural landscapes. Especially, the expansion of silage maize areas for use as feedstock for renewable energy production has led to growing environmental concerns (Lupp et al., 2014; Pedroli et al., 2013; SRU, 2007). In an effort to reduce the environmental side-effects of biogas production, recent amendments to the German EEG introduced upper bounds for the use of maize silage, an incentive to diversify substrate mixes and obligatory co-generation of heat-and-power.

A number of policy studies have examined how farmers respond to the incentives set by the EEG and consequently adapt their agricultural land use – with rather ambiguous insights. Goemann et al. (2010), for example, found that the 2009 amendment of the EEG could not be expected to lead to a reduction of maize production. It would rather lead to an increase in production and aggravate land competition, especially in regions with high livestock densities. In contrast, Delzeit et al. (2012, 2012b) expect the 2012 amendment to have a dampening effect on silage maize production. Schulze Steinmann and Holm-Müller (2010) found that maize silage is the most profitable feedstock, even when considering higher transport costs for larger, more centralized biogas plants – confirming similar results from Austria by Walla and Schneeberger (2008). More generally, Sorda et al. (2013) investigated the development and spatial distribution of biogas production in North Rhine-Westphalia and Bavaria over the next 20 years. They expect biogas production to increase for another ten years under EEG 2009 conditions, while a reduction of feed-in tariffs would considerably slow down biogas expansion and favor smaller plant sizes. An increase in electricity remuneration would, however, not significantly increase electricity generation from biogas.

Little attention has been paid so far to the interaction of biogas support policies with agri-environmental policy schemes. To a certain extent, this is a consequence of the high level of aggregation in conventional policy simulation models. The studies cited above analyzed investment decisions in biogas electricity generation by modeling a regional decision-maker representing the aggregated decisions of all farmers in a municipality or an even larger geographical area. In theory, assuming perfectly functioning regional markets and inter-farm cooperation, the simulated centralized optimization of biogas plants and their spatial distribution is equivalent to the aggregate outcomes of individual farmer decision-making as long as the so-called aggregation error has been minimized (Hazell and Norton, 1986). In reality, farmer cooperation is limited and both, biogas investments and participation in agri-environmental schemes, are especially dependent on farm-specific circumstances (Walla and Schneeberger, 2008; Delzeit et al., 2012; Delzeit and Kellner, 2013; Wilkinson, 2011). Payments for environmental services are seldom the main source of farm income nor the main driver of agricultural production decisions, but rather taken up if they fit into the general production setup of the farm.

In the present article, we therefore shift the scale of analysis: we employ a farm-level model to simulate both, the decision for investment in biogas production and the decision to participate in agri-environmental measures, as an integral part of the individual farmer decision-making. To derive regional-level results, we run our model for all full-time farm holdings of our study area, the Central Swabian Jura in South-West Germany, instead of only for a few representative agents. Our simulation results illustrate the potential magnitudes of interaction and conflicts between biogas support and agri-environmental policies.

The paper is organized as follows: after discussing the potential conflicts between biogas support and agri-environmental policies in the study area (Section "Biogas support and agri-environmental policies in Germany"), we describe the modeling approach and the setup of the simulation experiments in Section "Data & methodology". We examine (Section "Results") and discuss (Section "Discussion") the effects of both types of policy interventions on biogas capacity, silage maize area, farm incomes, land rents, grassland extensification and diversification of crop rotations. We conclude by identifiying research priorities to improve precision and reliability of estimates (Section "Conclusions").

Biogas support and agri-environmental policies in Germany

Our analysis focuses on the potential goal conflicts between the federal Renewable Energy Act (Erneuerbare Energien Gesetz, EEG) and the agri-environmental policy measures of the second pillar of the EU Common Agricultural Policy (CAP), which have been implemented under the name "Compensation Scheme for Market Easing and Landscape Protection" (Marktentlastungs-und Kulturlandschaftsausgleich, MEKA) in the state of Baden-Württemberg. The EEG aims to contribute to climate change mitigation, a global environmental goal, via the promotion of renewable electricity production, e.g. from biogas. As a consequence, it incentivizes the intensification of agricultural production, leading to the tendency of biogas farmers to specialize in silage maize production with adverse consequences to biodiversity and agricultural landscapes. Moreover, high profit margins and guaranteed revenues have driven up rental prices for farmland and favor large production units. The MEKA scheme, in contrast, comprises a portfolio of very diverse measures aiming mainly at environmental benefits that are rather local in scope. Goals include the conservation of biodiversity, landscapes resulting from traditional farming practices, and traditional animal breeds as well as a reduction of pesticide use – all generally associated with land-use extensification, rather than intensification of production.