Income effects of EU biofuel policies in Germany

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Abstract

The persistency of EU policies supporting first generation biofuels despite the clearly emerging picture of ecological benefits of this policy being small or even negative, leads to the conclusion that this policy is driven by other objectives such as its distributional effects. Against this background, the main objective of this article is to analyse income effects of an abolishment of biofuel policies at a disaggregated level for the German agricultural sector. Effects are estimated for different farm types and regions. Furthermore, differences between farm net value added and family farm income are analysed and distributional effects are estimated.

Keywords: biofuel policy, income effects, equilibrium model, farm group model

Introduction

In recent years, energy from biomass has been increasingly promoted as an alternative to fossil energy sources. In the European Union (EU), an increase in the share of liquid biofuels in the transportation sector has been politically fostered. According to the EU 'Renewable Energy Directive' (EC, 2009) each member state is required to ensure that 10% of total transport energy comes from renewable sources in 2020. The practical implementation of the 10% target is left to the EU member states. In Germany, the target mainly shall be achieved due to an obligatory blending quota for biofuels with fossil fuels (Rauch and Thöne, 2012).

The share of biofuels in total EU transportation energy evolved steadily and reached 4.27% by 2010, resulting, in combination with renewable electricity (0.43%), in a 4.7% total share of renewables in transportation. Up to date, biofuels mainly are made from crops – so called first generation biofuels (ECOFYS, 2012).

EU policymakers have pursued several proclaimed objectives with this policy: positive contributions to energy security, greenhouse gas (GHG) emission reduction, and income generation in rural areas were expected (Fonseca et al., 2010).

Yet, while legislators in the EU were focusing on increasing the use and production of biofuels, the economic and societal environment had fundamentally changed: due to a combination of agricultural policy reform and rising global agricultural prices, biomass has become scarce on EU markets. In addition, the true capacity of biofuels to be sustainable, climate- and people-friendly was increasingly questioned. High emission reduction costs were reported (Doornbosch and Steenblik, 2007) and shortly thereafter it was even questioned whether biofuels were contributing to GHG emission reductions at all (e.g. Searchinger et al. 2008).

In spite of evidence put forward against politically supporting first generation biofuels by a broad coalition of development as well as environmental NGOs, international organizations and academia, the direction followed by the EU biofuel policy seemed unaffected until recently (Grethe et al., 2013). In October 2012, the European Commission published a proposal for a Directive to amend the Renewable Energy Directive and the Fuel Quality Directive (European Commission 2012), limiting biofuels from food crops to 5% of total transport fuels.

The persistency of EU policies supporting first generation biofuels despite the clearly emerging picture of ecological benefits of this policy being small or even negative, leads to the conclusion that this policy is driven by other objectives such as its distributional effects. Keeney (2009, 3) analyses distributional effects of US biofuel policies and concludes that this "fills an important gap that improves our understanding of how biofuel policy impacts rural welfare and by extension provides insight into the political economic impacts of potential alternatives to status quo […] policies."

In this article we analyse income effects of changing biofuel policies in the agricultural sector. In general, it is concluded that a higher demand for biofuel feedstock will boost prices of agricultural commodities and thus, will increase income in the agricultural sector. Accordingly, an abolishment of biofuel policies is assumed to result in negative income effects. Many studies quantify the impacts of biofuel policies on agricultural commodity prices, however, without explicitly quantifying income effects.

Furthermore, only few studies report income effects at a disaggregate level (e.g. Louhichi and Valin, 2012). Most of these studies estimate impacts on farm net value added, but usually do not specify impacts on family farm income. Farm value added includes wages, rents and interest paid by the farm family and does not provide explicit information on how much the income of the farm family is affected.

Against this background, the main objective of this article is to analyse income effects of an abolishment of biofuel policies at a disaggregated level for the German agricultural sector. Effects are estimated for different farm types and regions. Furthermore, differences between farm net value added and family farm income are analysed and distributional effects are estimated. The structure of the paper is as follows: at first we present the underlying methodology before we describe the scenarios; in the subsequent section results are presented; and in the last section conclusions are drawn.

Methodology

To quantify income effects of changes in European biofuel policies, a modelling system consisting of an agricultural sector model and a farm level model of the German agricultural sector are applied. The modelling system is described in more detail in Deppermann et al. (2010). The linkage of the two models allows us to quantify adjustment processes at the sectoral level and at the same time to analyse farm group specific policy impacts at a more disaggregate level. In the following, the two models are briefly presented.

ESIM (Grethe, 2012) is a comparative-static, net-trade, partial equilibrium model of the European agricultural sector. It depicts the EU-27 at the member state level and also the rest of the world, though in greatly varying degrees of disaggregation. Altogether ESIM contains 31 regions and 47 products as well as a high degree of detail for EU policy including specific and ad valorem tariffs, tariff rate quotas, intervention and threshold prices, export subsidies, coupled and decoupled direct payments, production quotas, and set-aside regulations.

All behavioural functions (except for sugar supply) in ESIM are isoelastic. Supply at the farm level is defined for 15 crops, 6 animal products, pasture, and voluntary set-aside. Human demand is defined for processed products and each of the farm products except for rapeseed, fodder, pasture, set-aside, and raw milk. Some of these products enter only the processing industry (e.g. rapeseed) and others are used only in feed consumption (e.g. fodder or grass from permanent pasture). Processing demand is defined for raw milk (which is divided into its components, i.e., fat and protein), oilseeds, and inputs for biofuel production. The biofuel module depicts the production of bioethanol and biodiesel. Inputs for ethanol are wheat, corn, and sugar. Biodiesel is produced from rape oil, sunflower oil, soy oil and palm oil. Input ratios are endogenously determined by a CES function. Byproducts of biofuel production are accounted for and are used as additional feeding stuff in the livestock sector. The price formation mechanism in ESIM assumes an EU point market for all products except for non-tradables, for which the price results from a domestic supply and demand market clearing equilibrium at the EU member state level (raw milk, potatoes, fodder, silage maize, and grass).

FARMIS is a comparative-static process-analytical programming model for farm groups (Osterburg et al., 2001; Bertelsmeier, 2005; Offermann et al., 2005). Production is differentiated for 27 crop and 15 livestock activities. The matrix restrictions cover the areas of feeding (energy and nutrient requirements, calibrated feed rations), intermediate use of young livestock, fertilizer use (organic and mineral), labour (seasonally differentiated), crop rotations and political instruments (e.g., set-aside and quotas). The model specification is based on information from the German farm accountancy data network, supplemented by data from farm management manuals. Data from three consecutive accounting years is averaged to reduce the influence of yearly variations common in agriculture (e.g., due to weather conditions) on model specification and income levels. Key characteristics of FARMIS are: 1) the use of aggregation factors that allow for representation of the sectors' production and income indicators; 2) input-output coefficients which are consistent with information from farm accounts; and 3) the use of a positive mathematical programming procedure to calibrate the model to the observed base year levels. Prices are generally exogenous and are provided by market models. An exception to this applies to specific agricultural production factors, such as the milk quota, land, and young livestock, where (simplified) markets are modelled endogenously, allowing the derivation of respective equilibrium prices under different policy scenarios. FARMIS uses farm groups rather than single farms not only to ensure the confidentiality of individual farm data, but also to increase manageability and the robustness of the model system when dealing with data errors that may exist in individual cases. Homogenous farm groups are generated by the aggregation of single farm data. For this study, farms were stratified by region, type, and size, resulting in 628 farm groups which represent the German agricultural sector, of which 467 are located in western Germany. Table 1 provides an overview of the number and type of farms represented in different regions of Germany.

Table 1. Type and regional prevalence of farms represented in the analysis

	Total	North	South	Center	East
Number of farms	175,934	57,324	81,312	23,437	13,860
of which					
Arable farms	22%	24%	16%	20%	51%
Dairy farms	30%	24%	42%	15%	10%
Other grazing livestock farms	11%	12%	9%	11%	13%
Mixed farms	23%	26%	21%	20%	25%
Pig and poultry farms	5%	12%	3%	1%	1%
Permant crop farms	9%	2%	9%	33%	0%

NB: *North*: Nordrhein-Westfalen, Niedersachsen, Hamburg, Bremen, Schleswig-Holstein; *South*: Bayern, Baden-Württemberg; *Centre*: Hessen, Rheinland-Pfalz, Saarland; *East*: Berlin, Sachsen, Mecklenburg-Vorpommern, Sachsen-Anhalt, Thüringen, Brandenburg.

In other applications (e.g. Depperman et al., 2014) ESIM and FARMIS were linked through the exchange of solution variables (vectors of price and yield changes from ESIM to FARMIS and vectors of quantity changes from FARMIS to ESIM) until both models converged on these variables in the analysis of joint scenarios. However, for this study no significant feedback effects occurred such that in fact the models are coupled in a top-down manner, i.e. ESIM quantifying price changes at the sectoral level and FARMIS depicting production and income effects at the farm group level in response to the ESIM-simulated price changes.

Scenarios

The above described modelling system is calibrated to a base period (average of the years 2006-2008). The baseline (the reference scenario) and a reform scenario are conducted for the year 2020. To account for impacts of European biofuel policies, the reform scenario is evaluated in comparison to the baseline scenario and thus provides a comparative-static analysis of exogenous policy changes.

For the baseline scenario the EU is assumed to reach its renewable energy target of 10% in the transport sector in 2020. Furthermore, the baseline is based on population and income as well as technical progress projections, and on world market price projections as made by the OECD/FAO (2013). So-called first generation biofuels from oilseeds, cereals and sugar beet will account for 8% of total transportation energy of the EU in 2020. This includes the assumption, that the remaining 2% will be covered by renewable electro mobility and biofuels from waste and non-food lignocellulosic material. The biodiesel/bioethanol ratio, measured in energy content, will be 67/33. This compares to a recent (2010) ratio of 78/22 (ECOFYS 2012). In addition, the 2003 Reform and the Health Check of the Common Agricultural Policy are fully implemented except for the abolishment of milk quotas. No further changes in external trade policies of the EU are assumed until 2020.

As the only change compared to the baseline, the second scenario “NoSup” assumes the abolishment of all political support for biofuels produced from crops in the EU. In consequence, we assume that demand for biofuels from crops will drop from 8% to 1% of total transport energy, i. e. by 7 percentage points and that biofuel supply will fall accordingly to slightly less than 1% of total transport energy. This includes a long-term adjustment and assumes, that biofuels from crops will not be economically viable except in some niche markets (1%) due to their production cost being substantially above the cost price of fossil fuels. In the short run, the adjustment process may be slower as investments in refineries have already been made and installations may be kept running as long as the variable costs are covered. Under the “NoSup” scenario, the human demand for biofuels in countries other than the EU is assumed to remain constant compared to the reference scenario, i.e. lower biofuel demand in the EU will not, via falling international prices for biofuels, contribute to more biofuel demand in other countries. This is because many countries have defined quantitative targets for their biofuel demand, which results in non-price-responsive demand. Some countries, however, in which biofuel use is primarily market driven, such as Brazil, may extend their biofuel consumption whereas others, for which EU political action on biofuels may be a role model, may likewise reduce their supporting policies.

Results

A drop in demand of biofuels from crops accounting for 7 percentage points of energy consumed in the European transportation sector in our study amounts to 14 MTOE (Million tons of oil equivalent) of biodiesel and 7 MTOE of ethanol. The reduced demand for biofuels will result in a decline of processing demand for biofuel feedstock and thus lead to declining prices for agricultural products (Figure 1). The highest price impacts can be observed for oilseeds and, in particular, for rapeseed since a large share of European biodiesel is produced from rapeseed. Ethanol feedstock is much less affected than biodiesel feedstock mainly due to the relatively low share of ethanol in total biofuels and to the larger market size of these products. Due to a high level of integration between the EU and the world market, price changes in Germany are similar to changes at the world market.

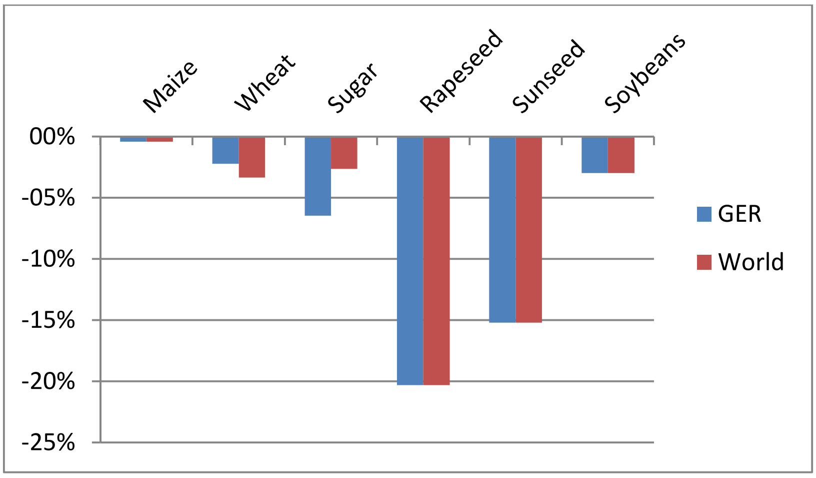

Figure 1. Price effects of the NoSup scenario relative to the baseline in 2020.

The estimated price effects are broadly in line with other studies, however, the variability of results is generally high and the price effects of this study are in the lower range, compared with other studies. Gohin (2008) e.g. calculates impacts of a 13.8 MTOE demand shock for biofuels and finds higher price effects for oilseeds (39% rapeseed) and wheat (10.8%) but also smaller ones for sugar (0.2%) and maize (0%). Louhichi and Valin (2012) estimate from a similar shock as carried out in the study at hand (21.8 MTOE first generation biofuels) that world market prices for rapeseed change by 22%, while EU prices change by 43.3%.

On the other side, some studies find lower price impacts. Edwards et al. (2010) e.g. report marginal price effects of additional biofuel demand. According to their simulation carried out with the AGLINK-COSIMO model, the shock simulated in this study would lead to a 2.6% decline in oilseed prices[1]. In Cororaton and Timilsina (2012) a more than 10% increase of biofuels in total liquid fuel demand for transportation in the EU and an additional increase of biofuel demand in other regions of the world lead to only 3% higher world market prices for oilseeds.[2]

Declining prices give incentives to farmers to decrease their production. A declining production in the German agricultural sector can be observed mainly for rapeseed and sunflower production (Figure 2).[3] Sugar is only slightly affected and cereal production even increases. Aggregate land use in the German agricultural sector only decreases by less than 0.1% (Figure 3). These effects partly occur due to the high share of rented land (68%, on average, in the baseline) as well as the high rate of capitalisation of price changes in land

[1] Not taking into account reported negative price effects on oilseeds arising from an additional demand for ethanol.
[2] A comparison of further studies is presented in Louhichi and Valin (2012, 247).
[3] However, in absolute levels rapeseed production is much more important (1538 t ha in the Baseline) than sunflower production (17 t ha).

prices which is assumed in FARMIS. As a result, land rental prices decline significantly in the NoSup scenario and thus, average production incentives are hardly affected. The production of crops with the highest price drops is substituted by other crops. Only the composition of aggregate production is affected due to changing relative prices among single commodities.

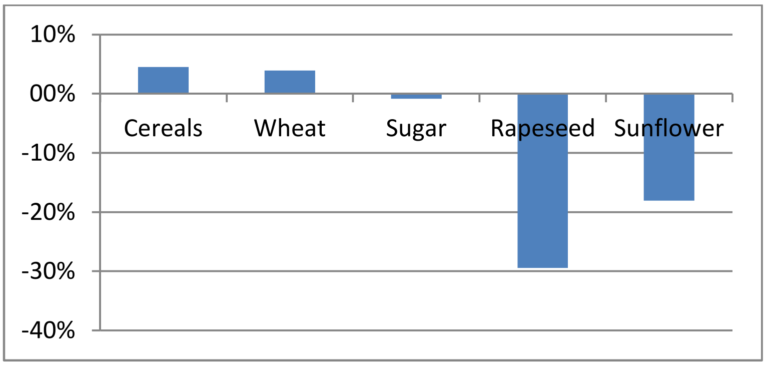

Figure 2. Supply changes of the NoSup scenario relative to the baseline in 2020 for the German agricultural sector.

Many studies (correctly) conclude from the fact that an additional (less) demand of biofuels causes higher (lower) prices and increases (decreases) agricultural income. However, the few studies that explicitly quantify income effects mostly apply farm net value added (FNVA) or related income indicators. FNVA includes wages, rents and interest paid by the farm family and does not provide explicit information on how much the income of the farm family is affected. In contrast, the indicator family farm income (FFI) provides information on the return to land, labour, and capital resources owned by the farm family, as well as the remuneration of entrepreneurial risk.

Fonseca et al. (2010) report, based on the CAPRI model, that overall farm income in the EU27 will decrease by 3.5% as reaction to a shock similar to the one modelled in this paper. It is not fully clear, however, which income indicator is used in this case, but from the model description it seems that wages, rents and interest paid are included in the income indicator. Louhichi and Valin (2012) calculate a 10% change in operating surplus for French arable farms. Gohin (2008) reports a change in agricultural value added of 3.8% in the EU15.

We find that FNVA for agriculture in Germany decreases by 3.9% (Figure 3). Due to the dominance of corporate farms in eastern Germany, no comparability between different farm structures could be ensured when using FFI as an indicator and thus, changes in FFI are displayed only for western Germany. To illustrate the difference between the indicators FNVA and FFI, both figures are presented for western Germany. Losses in FNVA are slightly lower (2.8%) when eastern German regions are excluded. However, income losses decline to 0.9% when FFI is used as an indicator. Thus, it is obvious that a large share of income losses for family farms can be compensated by reduced factor costs, especially for farms with a high share of rented land. This is of relevance in particular because a high share of the remuneration of land and capital leaves the agricultural sector and cannot be denoted as support to the agricultural sector.

Furthermore, in our analysis we find that labour demand is only affected to a minor extend by the reduced biofuel demand. While Gohin (2008) quantifies 43.000 additional jobs in EU15 due to biofuel policies, we only estimate a decline in labour demand by 0.19% (642 agricultural working units) for the German agricultural sector when biofuel policies are abolished.

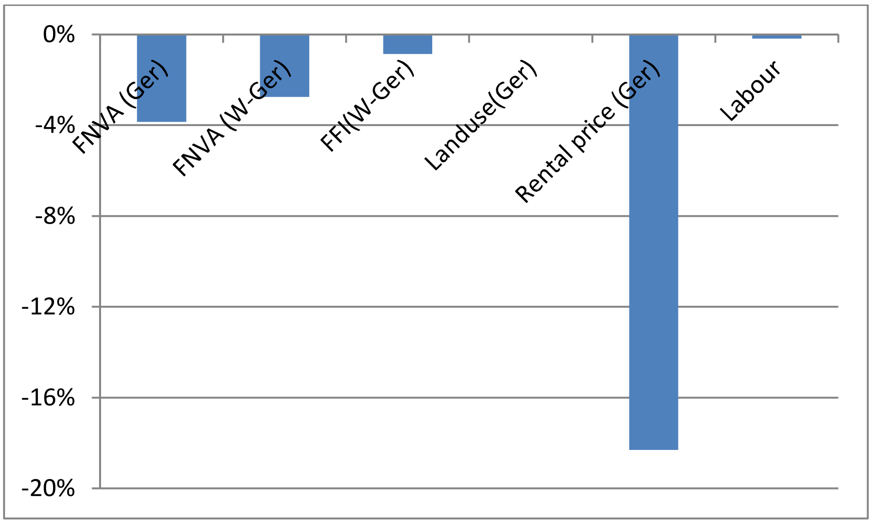

Figure 3. Aggregated income and factor use indicators of the NoSup scenario relative to the baseline in 2020 for the German agricultural sector.

The high rate of capitalisation of market revenue in land prices which is assumed in FARMIS reflects a long term perspective. In the short run, land markets might be less adaptive and income losses might be higher due to higher factor costs.

To account for the impact of the adaptiveness of the land market, in the following a sensitivity analysis is carried out. To this end, the differences of rental payments between the Baseline and the NoSup scenario for each farm group are calculated in an ex-post analysis of model results[4]. These differences reflect income losses that are compensated by falling land prices. Figure 4 reflects the changes of average FFI in western Germany when an increasing share of these differences is subtracted from original FFI values in the NoSup scenario. The first bar on the left side represents the average FFI losses for western German farms with original model assumptions (compare Figure 3) relative to Baseline results. The following bars represent FFI losses which reflect an increasing rigidity of the land market by additionally subtracting rent differences in 10% steps. When farms pay the same land rents in both the Baseline and the NoSup scenario, about 4% of FFI is lost compared to less than 1% in case of full land market flexibility (Figure 3).[5]

[4] Thus, model outcomes are not changed. This is in contrast with model outcomes being different, if land rents were higher. Nevertheless, differences in rents are a good proxy for cushioning effects of the land market.
[5] This is possible because income changes of FFI and FNVA do not refer to the same base.

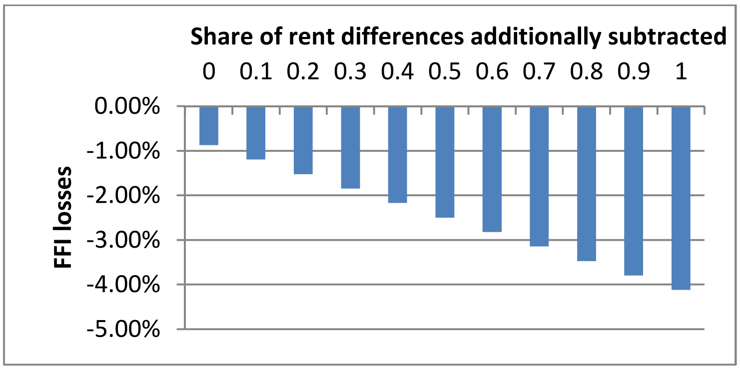

Figure 4. Sensitivity analysis of FFI losses with increasing rigidity of the land market.

In a disaggregated analysis we look at income effects on different farm types and different regions (Table 2).Very diverse effects appear with regard to different farm types. Arable farms are affected strongest since they have the highest share in oilseed and cereal production. This observation also fits with the results of Louhichi and Valin (2012), which found a 10% change in operating surplus for French arable farms. From a local perspective, farms in eastern Germany have, on average, to bear the highest losses. When taking long term FFI as an indicator, losses are much smaller compared to FNVA figures and some farms even have a positive income effect since they can profit from lower rental prices and are not or only slightly affected by declining prices of oilseeds or cereals. This is particularly the case for dairy farms in the northern regions and grazing livestock farms in central and southern regions.

Table 2. Disaggregated income effects of the NoSup scenario relative to the baseline in 2020.

FNVA	Arable farms	Dairy farms	Other grazing livestock	Mixed farms	Pig & poultry farms	Perma-nent crop farms	All farms
North	-6.85%	-1.48%	-1.03%	-3.04%	-1.39%	-0.02%	-2.94%
South	-6.41%	-1.17%	-1.65%	-3.17%	-4.14%	-0.30%	-2.39%
Centre	-9.58%	-1.89%	-0.21%	-5.76%	-3.20%	-0.13%	-3.25%
East	-13.22%	-3.03%	-1.35%	-5.91%	-2.71%	-0.05%	-7.68%
FFI							
North	-4.54%	-0.04%	-0.37%	-1.14%	-0.57%	-0.06%	-1.18%
South	-1.76%	-0.13%	0.68%	-0.53%	-3.42%	-0.19%	-0.52%
Centre	-4.14%	-0.20%	2.67%	-2.03%	-2.34%	0.02%	-0.97%

NB: *North*: Nordrhein-Westfalen, Niedersachsen, Hamburg, Bremen, Schleswig-Holstein; *South*: Bayern, Baden-Württemberg; *Centre*: Hessen, Rheinland-Pfalz, Saarland; *East*: Berlin, Sachsen, Mecklenburg-Vorpommern, Sachsen-Anhalt, Thüringen, Brandenburg.

Looking at distributional impacts of an abolishment of biofuel policies reveals no strong changes in overall inequality indicators such as the Gini coefficient due to the small amount of absolute income losses (similar findings are presented for the US in Keeney, 2009).

However, by measuring the distribution of income losses, the degree of progressivity of the policy change can be obtained. A suitable measure is the concentration index of income changes C_B (Allanson, 2008) which indicates how income losses are distributed among the farm population. A positive (negative) C_B indicates that farms with higher incomes have to bear a higher (lower) absolute burden than farms with lower incomes. With a fully flexible land market a C_B value of 0.349 is obtained for FFI in western Germany. With a fully rigid land market C_B amounts to 0.2813. From this it can firstly be concluded that farms with higher incomes in the Baseline, on average, have to bear higher absolute income losses. Secondly, since the measure decreases with a rigid land market, it can be concluded that the distribution of losses in this case is more favourable for higher income farms which in turn means that farms with lower incomes more than proportionally benefit from a flexible land market.

Conclusions

We analyse effects of an abolishment of biofuel policies in the EU. Income effects are analysed at a disaggregate level and it is differentiated between farm net value added and family farm income. We find that an abolishment of biofuel mandates has, on average, a negative impact on agricultural income. However, in case of family farm income only some farms have losses while others even benefit from lower rental costs and have positive income effects. Arable farms have to bear the highest losses and from a regional perspective, losses are highest among farms in eastern Germany.

A drawback of our analysis is that only income effects in the agricultural sector are considered and effects on profits in the biofuel producing industry are not accounted for.

In general, income effects in the agricultural sector are small, mostly when only the remuneration of factors belonging to the farms is considered. Landlords profit from biofuels policy with a high share of rental land in Germany and many landlords not being active farmers.

From our findings we can support Gohin (2008, 640) who concluded that the transfer efficiency of biofuel policy is limited and as a consequence “the EU biofuel policy cannot be justified only on those grounds.” Additionally, we find that farms with a higher income benefit more in absolute terms from the policy than farms with lower incomes. In addition, the fact that a specific group of farms (arable farms) mainly profits from this policy while others have disadvantages due to higher rental prices may be interesting from a political economic point of view.

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