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**An ex-ante analysis of distributional effects of the CAP on  
western German farm incomes**

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## **An ex-ante analysis of distributional effects of the CAP on western German farm incomes**

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### *Abstract*

*This study is concerned with measuring impacts of the Common Agricultural Policy (CAP) on farm income distribution of western Germany. Not only the sheer contribution of market price support and direct payments as a proportion of income is taken into account, but also the impact of support on production incentives. For this purpose, we apply a modelling system consisting of a partial equilibrium model and a programming model. Based on a comparison of Gini coefficients and a decomposition of overall inequality effects we conclude that liberalization of the agricultural sector leads to a more unequal distribution of family farm income in relative terms, whereas a liberalized market provides a more equal situation in absolute terms.*

*Keywords: Income distribution, CAP, Farm Group Model, Equilibrium Model*

*JEL classification: Q11, Q12, Q18, C54, C6, D31*

### **1. INTRODUCTION**

Among other motives, agricultural policy is often justified as income support to farm households for equity matters. This is especially true for first pillar measures of the CAP. It is well known that this policy is not free from major imperfections, such as low transfer efficiency and high transaction costs. But does the CAP reduce income gaps in the agricultural sector at all? What kind of distributional effects would a further liberalization of the European agricultural sector entail? This paper aims at contributing to ongoing research trying to answer these questions. In recent years, several studies concerned with redistributive effects of agricultural policy have been carried out via the application of different methods.

OECD (2003) measures the degree of concentration of gross farm receipts, agricultural support and net operating income per farm by estimating relative Gini coefficients and Lorenz curves. Based on a comparison of these measures, the authors conclude that for most OECD countries under consideration, agricultural support has relatively small effects on distribution by farm size because the distribution of agricultural support is only marginally less unequal than the distribution of gross receipts.

Schmid et al. (2006) compare relative Gini coefficients of direct payments per farm holding for single EU-15 member states. They show that the degree of distribution of direct payments is fundamentally different yet is closely related to the concentration of land inside the respective member states. In a more detailed analysis for Austria, they find that larger holdings get the bulk of direct payments and that less favored area payments only have little equalizing effects.

A prominent method to detect income distribution effects of agricultural policy is based on a decomposition of the Gini coefficient of income inequality by single income sources. Von

Witzke and Noleppa (2007) decompose a relative Gini coefficient as well as a related measure of absolute inequality of total farm profit into components for direct payments and market profit. The authors conclude that direct payments account for about one-third of overall inequality for family farms and for two-thirds of overall inequality for incorporated farms.

Keeney (2000) goes one step further: based on a decomposition of a relative Gini coefficient for family farm income, the impact of marginal changes in direct payments and market income on total inequality is reported. According to this study, direct payments reduced relative income inequality in Ireland between 1992 and 1996.

Several similar studies have been carried out for U.S farm households. For example, Ahearn et al. (1985) analyze the effects of direct government payments on income of farm operator households in 1984. They find little equalizing effects of direct government payments at the margin in relative terms, arguing that this finding might hold in the short run only as their data set included a high proportion of large farms with negative incomes. They conclude that off-farm employment opportunities have a higher potential to equalize household incomes than government payments. Mishra et al. (2009) investigate relative inequality effects of government payments on farm household incomes, differentiated for nine farming regions in the U.S. They find that income from government programs decrease total income inequality, though regionally differing in extent. Furthermore, they highlight the important role of off-farm income for the reduction in inequality.

The method of decomposing the Gini coefficient into its single income sources used by the studies cited above serves well as a measure of the marginal impact of each income source to overall inequality. Nevertheless, this method cannot be used to detect different characteristics of inequality, such as the distinction between vertical and horizontal effects of redistribution.

To account for the different dimensions of impacts from inequality, Allanson, through a series of papers, uses another approach which is based on a comparison of Gini indices of pre- and post-support income distribution. Allanson (2006) estimates changes of relative Gini coefficients for Scottish farm households. In this paper, the overall redistribution effect of agricultural policy support is split up into a vertical dimension of inequality and a re-ranking effect. An unequalizing overall effect of agricultural policy is found which is caused by re-ranking effects overtaking the equalizing vertical effects. The method is extended in Allanson (2008) by additionally accounting for classical horizontal inequity. The unequal treatment of pre-transfer equals is found to be the main reason for the increase in overall inequality. Allanson (2007) uses this method with relative and absolute measures of inequality. Allanson and Rocchi (2008) find similar results through a comparative analysis for Tuscany and Scotland.

In a completely different approach, Rocchi (2009) uses a SAM-based model to analyze income distribution changes from the single payment scheme of the CAP for Italy. This approach is able to distinguish between direct and indirect impacts of agricultural policy on income distribution among agricultural as well as non-agricultural households. However, the analysis is carried out at a highly aggregated level and does not take price effects into account.

Similar to Allanson (2006), our paper uses the Gini comparison method to account for different dimensions of distributional effects of agricultural policy on farm income in western Germany. Previous research is extended by executing an ex-ante analysis of income effects of changes in agricultural policy for 2015 based on an equilibrium model. Thereby, incentive effects are fully taken into account for the first time. Major drawbacks of the analysis framework include unconsidered effects of structural changes not depicted in the modelling system and the need for grouping micro data, though we undertake this at a relatively low aggregation level. Specifically, we identify impacts of liberalizing the European agricultural sector on farm income distribution for two different scenarios in relative and absolute inequality terms. Furthermore, we analyze the relevance of nonfarm income for effects on inequality in the case of liberalization.

The structure of the paper is as follows: in Section 2 we first present the underlying modelling system before describing our method of measuring distributional effects, the data and scenario assumptions; in Section 3 we present the results, beginning with sectoral results before redistributive effects of the CAP and nonfarm incomes are introduced; and in Section 4 we provide a summary and conclusions.

## **2. METHODS AND DATA**

### ***2.1. Modelling Approach***

In our analysis of distributional effects of agricultural policy, we account not only for the sheer contribution of market price support and direct payments as a proportion of income, but also for the impact of support on production incentives. For this purpose, we apply a modelling system consisting of a partial equilibrium model and a programming model (for a detailed description, see Deppermann et al., 2010). The partial equilibrium model is the European Simulation Model (ESIM) which quantifies effects of agricultural policies at the European and German level, while the programming model is the Farm Modelling Information System (FARMIS) which measures impacts on intra-sectoral income distribution among farm groups in Germany.

ESIM (Banse et al., 2010) is a comparative-static, net-trade, partial equilibrium model of the European agricultural sector. It depicts the EU-27 at the member state level with a strong focus on EU common agricultural policies. Altogether ESIM contains 31 regions and 47 products and a high degree of EU policy detail 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.

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), labor (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 covering about 11,000 farms, supplemented by data from farm management manuals. Key characteristics of FARMIS are: 1) the use of aggregation factors that allow for a 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. 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 597 farm groups.

The two single models are fully integrated via iteratively exchanging vectors of solution variables until both models converge on these variables in the analysis of joint scenarios.

## **2.2. Measurement of Distributional Effects**

In this article we analyze redistributive effects of agricultural policy by comparing different scenarios calculated with the described modelling system. One scenario assumes the status quo of agricultural policy until 2015 and two scenarios assume different states of liberalization. The question we pose is whether agricultural policy makes income among western German farms more equally distributed.

At least in the short run (because we cannot account for structural changes triggered by liberalization), liberalization has clear negative impacts on farm income on average (Deppermann et al., 2010). Yet how can we talk about equalizing effects in a case where mean income is not comparable? As Lambert (2001) points out, this is possible because we implicitly compare the new situation with another one in which income would have been reduced in a distribution neutral way. The latter is used as a natural benchmark to evaluate distributional effects.

Based on Musgrave and Thin (1948), Kakwani (1986) develops a measure of redistribution that is based on a comparison of relative Gini coefficients and decomposes the total effect into a vertical and a re-ranking component, which Allanson (2006) applies to agricultural policy:

$$R = G_x - G_y = (G_x - C_y) + (C_y - G_y) = V + H \quad (1)$$

where R represents the overall effect of redistribution as the difference of the Gini index in the base situation ( $G_x$ ) and the Gini index in the new situation ( $G_y$ ),  $C_y$  is the concentration index<sup>1</sup> of income in the new situation, and V and H are indices of vertical redistribution and re-ranking,

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<sup>1</sup> The concept of concentration indices is closely related to the concept of the Gini index; however, instead of ranking income in ascending order, income units are kept in the position of another distribution. The new income situation is combined with the old ranking. The Gini index of the new situation equals the Concentration index in the case where no reranking occurs.

respectively. Generally, the concept of vertical equity represents the idea that a monetary burden on individuals should increase with their capacity to bear that burden. A positive (negative) sign for  $V$  indicates that in case of income losses, in our case due to a reduction of government support, the burden is progressively (regressively) allocated among the total farm population. Nevertheless,  $V$  does not measure the “pure” degree of deviation from a proportional burden share because it also depends on the average rate of burden. This becomes obvious with a further decomposition of  $V$ :

$$V = G_x - C_y = \frac{P \cdot s}{(1-s)} \quad (2)$$

where  $s$  represents the rate of average burden of the whole farm population and  $P$  represents the Kakwani (1977) measure of progressivity which equals  $C_B - G_x$ , with  $C_B$  being the concentration index of burden.<sup>2</sup>  $P$  measures the extent to which burden payments are distributed more unequally or equally than income in the base situation (Aronson et al., 1994). But the degree of deviation from a proportional share of burden does not entirely explain the new state of distribution (Atkinson, 1980; Plotnick, 1981). The index of vertical redistribution equals the overall effect of redistribution only in case where no re-ranking of farms occurs. In our analysis this would be if farms were arranged in ascending order of their income in the baseline situation and still hold the same rank after liberalizing the agricultural sector. Otherwise the index of vertical equity overestimates the redistribution effect by also including rank reversal effects. To illustrate the impacts of re-ranking on inequality, let us assume an extreme case in which, due to an imaginary policy, all individuals of a population have to switch their income: the highest income is replaced with the lowest, the second highest income with the second lowest and so on. This policy would be highly progressive (as the highest incomes have to bear the highest burden and the lowest incomes get the most), but there would be no change in the overall distribution. To account for re-ranking, the index  $H$  (which is also known as the Atkinson-Plotnik-index of re-ranking) is applied in equation (1). It can be interpreted as an indicator of arbitrariness or discrimination of the examined income redistribution system. Atkinson (1980) refers to the effect as “mobility” induced by an income policy, which might be of interest in its own right. If re-ranking occurs, it always has a negative impact on the overall redistribution index (Lambert, 2001).

Aronson and Lambert (1994) point out that several scholars equated the re-ranking effect with the concept of horizontal equity. These scholars argue that horizontal equity, classically defined as the equal treatment of equals, must be violated if re-ranking occurs. In another approach Aronson and Lambert (1994) identify re-ranking as a component separate from classical

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<sup>2</sup> In our paper we treat the reduction of income caused by liberalization like a tax. In case one wants to measure the effects of cash benefits, the formula should be  $V=(G_x-C_B)/(s/1+s)$ .



horizontal equity and decompose the overall effect of redistribution into a vertical (VE), a re-ranking (RR) and a classical horizontal component (CH):

$$R = VE - CH - RR \quad (3)$$

To identify classical horizontal inequity, they build groups of equal income individuals and measure inside-group inequality. We do not use this approach because our calculation is based on average income of homogenous farm groups and therefore we could not detect any inside-group inequality.

The described approach was so far based on the *relative* Gini coefficient. One property of relative measures of inequality is that proportional changes in all incomes do not change inequality (they are scale invariant). Instead, it depends on the subjective evaluation of how inequality is affected by particular types of income changes (Chakravarty, 1990). Thus, in our analysis we apply as a second measure the *absolute* Gini index. The two concepts are closely related – the absolute Gini is obtained by multiplying the relative one with the mean income of the sample – but they react differently on income changes. Absolute measures of inequality are invariant to equal absolute changes in all incomes, i.e. inequality is unaffected in case an equal amount is added to all incomes (Kolm, 1976). Generally, the described method of decomposing the overall redistribution effect can similarly be applied to the absolute Gini, as well (Allanson, 2008).

### 2.3. Data

With the above described modelling system (see Section 2.1) different scenarios were conducted for the year 2015 with the model base period in 2004/2005 (see Deppermann et al., 2010). To measure income inequality among farms in the western German agricultural sector, our indicator is family farm income (FFI). FFI provides information on the return to land, labor and capital resources owned by the farm family, as well as information on entrepreneurial risk. Due to the dominance of corporate farms in eastern Germany, we concentrate on western Germany because no comparability between different farm structures could be ensured when using family farm income as an indicator.

In the base period, income data for 357 homogenous farm groups (for western Germany) are generated based on information from the German farm accountancy data network covering about 11,000 farms, supplemented by data from farm management manuals. Farms are grouped by region, type and size. Average values of farm attributes are used in the modelling analysis. Each group is weighted with an aggregation factor to represent its correct proportion of the basic population. Income indicators are not explicitly considered when grouping the data which complicates the analysis of income distribution effects. Due to grouping the data and working with average values instead of micro data, some information on inequality is lost. For the base period we can observe both individual and grouped data. A comparison of the relative Gini co-

efficient reveals some differences in inequality for the base period (the Gini coefficient of single farm income data = 0.625 and the Gini coefficient of farm group income data = 0.36).

For our projection year 2015, we have grouped data only. A proposed solution to deal with the problem of grouped data is to calculate a minimum and a maximum level of inequality for the distribution (e.g. Cowell, 2009); however, in our case this approach is not appropriate. As the upper and lower income bounds of the single groups are unknown in 2015 (theoretically a single farm inside a group can make infinite gains or losses which we cannot observe), it would be meaningless to calculate a maximum level of inequality. The inequality level we measure among farm groups in 2015 is the minimum level of total income inequality. Because of dealing with average values for farm groups, distribution among single farms cannot be more equal even if inside-group inequality is not observed. Yet, referring to a change in the Gini coefficient of inequality among farm groups, we cannot conclude that it is the minimum change in the Gini coefficient of inequality among single farms (which we cannot observe). In the base year we assume total equality inside the groups. Thus, in the model framework inside-group distribution cannot become more equal in 2015 compared to the base year, but in reality it definitely could. Hence, we analyze changes in distribution among farm groups only.

To draw conclusions for the total farm population (including inside-group inequalities), we would have to rely on assumptions such as the assumption that inside-group inequality is constant over time. This assumption may be valid as farms are quite homogenous in factor endowment and production structure inside the groups. Thus, within-group differences of incomes mainly occur due to different management abilities of the farm operator or other unobserved effects. As first pillar CAP support generally is linked to output or factor endowment, its effect on within-group income differences should be small. Therefore we would assume that within-group distribution in different scenarios is similar to the observed distribution in the base period.

#### **2.4. Scenarios**

Three different scenarios are compared regarding their income distribution: a reference scenario (baseline) and two different liberalization scenarios. In the baseline, the 2003 Reform and the Health Check of the CAP are fully implemented except for the abolishment of milk quotas. Milk quotas are assumed to increase until 2015 according to the Agenda 2000 decision, including the additional 2% quota increase in 2008 and the fat adjustment in 2009/10. It is assumed that a biofuel share of almost 6% in total EU transport fuel consumption will be reached by 2015. Furthermore, the sugar market reform is implemented and set-aside obligations are removed in 2008. The baseline adopts constant levels of tariffs, export subsidies, tariff rate quotas (except for sugar) compared to the base situation and the current system of intervention prices. For the international environment, ESIM is calibrated to FAPRI world market price projections (FAPRI, 2009) and no changes in external trade policies of the EU are assumed until 2015.

To account for the effects of agricultural policy on income in the agricultural sector, the baseline results in 2015 are compared to results of a second scenario in 2015 (henceforth, liber-

alization scenario). The latter assumes a full market liberalization of EU agricultural policies (i.e., the abolishment of all intervention prices, tariffs, quotas and subsidies) and a cut in direct payments by 50%. That means that in 2015, the EU price level equals the world market price for tradable products. A total abolishment of direct payments would lead to strong supply changes in FARMIS, which are likely to be dampened in reality by structural changes within the farming sector as well as other components of the value chain such as the input industry. These changes, however, are not depicted in the current model versions. In a third scenario (henceforth, 50% DP cut scenario) isolated effects of a separate 50% reduction of direct payments are analyzed.

In the second part of our analysis we consider the impact of liberalizing the agricultural market on income distribution under the additional consideration of nonfarm income. For measuring the impact of nonfarm income, we compare the effects of liberalization on the distribution of FFI both including and excluding nonfarm income of the farm operator and his or her spouse. Data on nonfarm income are not included in the modelling system. Consequently, they are available for the base period of the scenarios only. We assume that the real absolute value of nonfarm income does not change over time<sup>3</sup>.

### **3. RESULTS**

#### ***3.1. Sector results***

According to the model results, a 50% cut in direct payments has almost no impact on agricultural prices and production. In contrast, the liberalization scenario leads to a significant reduction of the prices of crop products (- 22% on average), pork (-16%), beef (-55%) and milk (-27%). In Germany, cereal and, in particular, arable fodder production are reduced and a significant increase in unused (set-aside / mulching) areas is observed. Beef and pork production decrease by 27% and 7 %, respectively. Compared to the baseline scenario, farm net value added per agricultural work unit is reduced by 14% in the scenario with a 50% cut in direct payments and is reduced by 55% in the liberalization scenario. The decrease of FFI is partly cushioned by lower land rental prices, especially in farms with a high share of rented land. Moreover, on average the sum of FFI and wages per agricultural work unit<sup>4</sup> is cut by 7% and 50%, respectively, in these two scenarios.

#### ***3.2. Redistributive Effects of the CAP***

Figure 1 provides an overview of the distribution of FFI in western Germany for all three scenarios. Henceforth, we will refer to FFI simply as income for matter of convenience. The

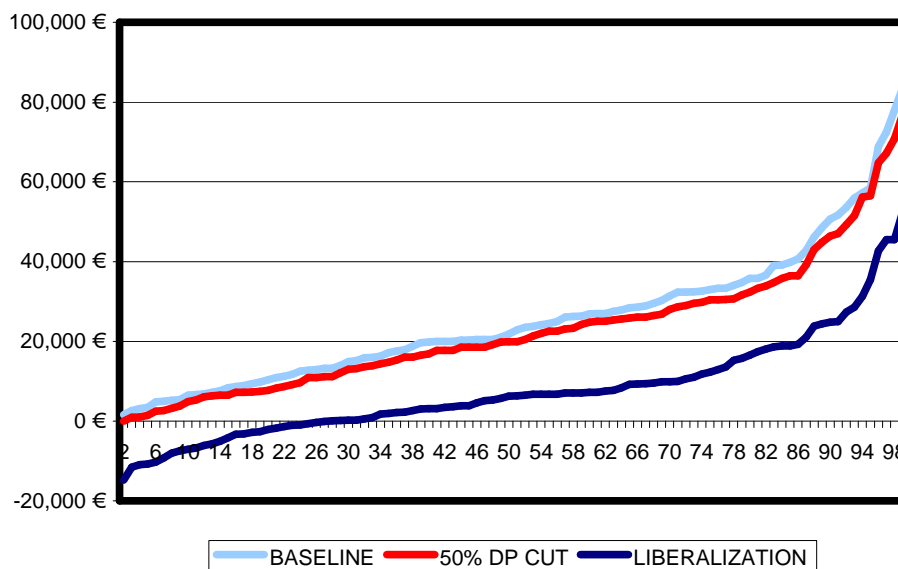
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<sup>3</sup> Actually, it is likely that nonfarm income and government support are negatively correlated (e.g. Vergara et al., 2004; Kwon et al., 2006).

<sup>4</sup> This income indicator is often used in Germany to ensure comparability between different farm structures in light of the present dual structure of family and corporate farms.

curves in the graph represent percentile values.<sup>5</sup> The light blue line on the top depicts the income distribution in the year 2015 which is our baseline scenario. Percentile values increase quite constantly until the 85<sup>th</sup> percentile is reached and then increase more steeply with higher percentiles, hinting at high income concentration in the upper part. The next two lower lines represent income percentiles of the scenario with a 50% cut in direct payments (50% DP cut) and the scenario with an additional abolishment of all price policies (liberalization). According to the model results, liberalizing the agricultural sector has clear negative impacts on farm income. In the liberalization scenario 26% of farms have negative incomes, whereas in the baseline there were only very few farms with negatives incomes. However, these projections should be interpreted against the background that with this low-level income, significant structural change can be expected which is not depicted in current model specifications. The distance between the different lines can be interpreted as the value of income generated by agricultural policy. At first glance, it seems that agricultural support is more or less equally distributed in absolute terms even though the distance increases some from the median on. Such a lump-sum-transfer-like reduction of income would result in a more unequal relative income distribution. Yet, based on Figure 1, one can say nothing about re-ranking effects because for each scenario income percentiles are ranked again in ascending order.

Figure 1: Percentiles of FFI in 2015 for various scenarios (western Germany)



Source: Own calculations.

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<sup>5</sup> This goes back to Jan Pen's (1971) idea of visualizing distributions by charting their quantile functions.

Table 1: Decile groups, based on FFI for western Germany

De-ciles	Baseline income		Liberalization scenario				50% DP cut scenario			
	(I)		Income after liberalization		Difference (Support)	Support / base income	Income with 50% DP cut		Difference (Supp.)	Support / base income
	(Ia)	(Ib)	(IIa)	(IIb)	(III)	(IV)	(Va)	(Vb)	(VI)	(VII)
	€/farm (av.)	% of all	€/farm (av.)	% of all	% of total support		€/farm (av.)	% of all	% of total support	
1	2,468	1	-3,744	-5	3	2.52	536	0	7	0.78
2	8,180	3	1,970	3	3	0.76	6,781	3	5	0.17
3	12,497	5	-1,373	-2	8	1.11	10,046	4	9	0.20
4	17,134	7	4,813	6	7	0.72	14,956	7	8	0.13
5	20,368	8	8,396	11	7	0.59	18,584	8	7	0.09
6	24,665	10	8,123	11	9	0.67	22,390	10	9	0.09
7	28,394	11	4,718	06	13	0.83	25,598	11	11	0.10
8	33,222	13	8,063	11	14	0.76	30,191	13	12	0.09
9	41,119	16	8,948	12	18	0.78	37,414	16	14	0.09
10	65,560	26	35,265	47	17	0.46	60,809	27	18	0.07
All	25,361	100	7,518	100	100	0.70	22,730	100	100	0.10

Source: Own calculations.

In Table 1 total farm population is segmented into decile groups: ten groups of equal size with the bottom group containing 10% of farms with the lowest incomes and the top group covering the highest incomes. In the column on the left (I), the baseline income of each decile group is reported. The next three columns (II – IV) refer to the liberalization scenario in case that composition of decile groups does not change. Farms that had the lowest income under the baseline scenario are still located in the bottom decile. It is noticeable that higher decile groups after liberalization do not necessarily have a higher share of income anymore. This is a first hint that significant re-ranking effects might occur. For example, the third decile group has a negative income, while the second has a positive income under the liberalization scenario. One can interpret the difference in income between the baseline and the (two) scenario(s) as the effect of agricultural policy support (which, in fact, is a loss in our case as policy support is reduced). Column III presents for each decile group its share in total support. On the one hand, it shows that support is not equally shared among the groups: with liberalization high income farms take a higher burden than low income farms in absolute terms. On the other hand, it also shows that support is more equally distributed than income. The bottom decile group gets (or with liberalization, loses) only 3% of total support and the top decile 17%; however, for the bottom decile support is equal to 252% of baseline income, while for the top decile it is only 46%. The effects of a sole reduction of direct payments by 50% are comparatively moderate. This is partly due to the high rate of capitalization of direct payments in land prices which is assumed in FARMIS.

As a consequence, land rental prices decrease significantly with a reduction of direct payments, which cushions negative income effects especially for farms with a high share of rented land.

Table 2: Decomposition of changes in relative income inequality

Relative inequality (scale invariant)		Liberalization Scenario	50% DP Cut Scenario
Gini coefficient of baseline income	$G_x$	0.377	0.377
Gini coefficient of scenario (after policy change)	$G_y$	0.966	0.402
Concentration coefficient of scenario	$C_y$	0.611	0.399
Concentration coefficient of support (base income – scenario income)	$C_B$	0.278	0.182
Average rate of support (support/base income)	$s$	0.70	0.10
Total redistributive effect	$R$	-0.589	-0.025
Index of re-ranking	$H$	-0.356	-0.002
Index of vertical equity	$V$	-0.231	-0.024
Index of progressivity of support	$P$	-0.099	-0.195

Note: Gini and concentration coefficients are estimated using the *sgini* Stata command developed by Van Kerm (2009).

Source: Own calculations.

After considering shares in absolute income and support in Table 1, we now refer to the concept of relative inequality. The relative Gini coefficient in the baseline situation is 0.377. A comparison to the Gini coefficient from the liberalization scenario (0.966)<sup>6</sup> indicates a strong change in overall inequality (see Table 2). With an overall distribution index  $R$  of -0.589, income is much more unequally distributed in terms of relative inequality in a liberalized market than it is in the baseline.  $P$  is slightly negative which indicates that the burden of liberalization is not proportionally shared among all farms. Small incomes bear a disproportionately high share of the burden from liberalization, which is caused by the higher share of support in income for small farms. Graphically, this would entail that the concentration curve of burden lies inside the Lorenz curve of baseline income.

The sign of  $P$  determines the sign of the index of vertical redistribution  $V$ . The latter increases with an increasing share of total burden on total baseline income ( $s$ ). We can conclude that the vertical component of liberalization increases relative inequality ( $V = -0.231$ ). This effect is augmented by re-ranking, which per definition always has a non-positive effect on equality. Re-ranking even contributes the majority of the unequalizing effect of liberalization to the overall effect ( $H = -0.356$ ).

The bottom line is that in relative terms farms with a higher income in the baseline tend to lose a lower share of their incomes due to an abolishment of agricultural policy than farms with lower income. But taking into account only the distribution of the burden from liberalization

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<sup>6</sup> Here a Gini coefficient close to one does not necessarily mean that income distribution is close to maximum inequality because under the liberalization scenario several negative incomes are included in the data. Consequently, a Gini coefficient might even take values higher than 1.

would underestimate the distributional effect due to an arbitrary design of support which leads to major re-ranking effects. Compared to the liberalization scenario, a cut in direct payments causes relatively low distribution effects. Even though P has a higher (negative) value compared to the liberalization scenario, distributive impacts are lower. This is because the share of the total burden of liberalization on total baseline income is relatively small (10%). Re-ranking effects virtually do not occur.

Now we turn our attention to the absolute Gini comparison (Table 3). The absolute Gini index is invariant against absolute changes of income. The overall absolute effect of redistribution (AR) for the liberalization scenario is positive, which indicates that – in absolute terms – the distribution of income is more equal in the new situation. The absolute index of vertical equity is positive (which is a mandatory condition in case of a positive R as H always has a negative sign), so farms with higher income tend to bear a higher absolute burden from liberalization compared to farms with lower income. The re-ranking effect reduces the vertical component by about half its size. Similar, but much more moderate effects occur in the scenario of a 50% reduction of direct payments.

Table 3: Decomposition of changes in absolute income inequality

<b>Absolute inequality (invariant to absolute changes)</b>		<b>Liberalization Scenario</b>	<b>50% DP Cut Scenario</b>
Absolute Gini index of baseline income	AG <sub>x</sub>	9564	9564
Absolute Gini index of scenario	AG <sub>y</sub>	7266	9119
Absolute total redistributive effect	AR	2297	444
Absolute index of re-ranking	AH	-2673	-34
Absolute index of vertical equity	AV	4970	478

Note: Absolute Gini indices are estimated using the *sgini* Stata command developed by Van Kerm (2009).

Source: Own calculations.

The different evaluation of changes in distribution depending on the applied measure of inequality is interesting regarding the discussion on which design is best for agricultural policy. As, for example, Allanson (2006, p. 4) argues, an absolute measure might be better suited as the “presumed proportionality of transfers is precisely the basis of the widespread criticism of existing farm support programs as poorly targeted and inequitable”. Following this line of argument, the CAP indeed leads to a more unequal distribution compared to a situation with a liberalized agricultural market.

In an analogous calculation (figures not presented here) for the whole German agricultural sector we find similar results; however, due to the dominance of corporate farms in eastern Germany, FFI is not applicable as an indicator. FFI plus wages per agricultural working unit is used to ensure comparability between different farm structures. For both the relative and absolute indices, trends go in the same direction, though they differ in their extent. Nevertheless, the interpretation of the indicator FFI plus wages would be somewhat different as we compare distributions regarding their return to labor and unpaid factors owned by the farm operator per agricultural working unit.

### **3.3. Distributional impacts of nonfarm income**

In this section we present our results concerning the impact of liberalizing the agricultural market while also considering nonfarm income. Therefore we compare the analysis of the indicator FFI (Section 3.2) with an analysis of the indicator FFI plus nonfarm income, both based on relative Gini coefficients. Nonfarm income is not part of the modelling system described in 2.1 and we assume data of the base period to be constant. This probably leads to an underestimation of inequality compensation effects of nonfarm income because it can be expected that nonfarm income and government support are negatively correlated (e.g. Vergara et al., 2004; Kwon et al., 2006).

In the baseline scenario, nonfarm income and FFI are slightly negatively correlated.<sup>7</sup> Thus, one would expect a lower Gini coefficient for the baseline. This can be confirmed as the Gini coefficient when including the nonfarm income is 0.290 compared to 0.377 in the case in which nonfarm income is not included (Table 4). Quite a high difference can be realized when comparing the two Gini coefficients in the liberalization scenario. The Gini coefficient is roughly one-third lower when nonfarm income is included, which leads to a relatively low R. The decomposition of R shows that the vertical effect V becomes very small (-0.069), but that the re-ranking effect H stays at quite a high level. We can thus conclude that many farms with a relatively small baseline FFI and a relatively high nonfarm income ascend due to liberalization in the ranking and overtake farms with primarily higher FFI and a relatively low nonfarm income. By additionally taking into account nonfarm income, the overall unequalizing effect of liberalization is significantly reduced.

Table 4: Decomposition of changes in relative income inequality for FFI and FFI plus nonfarm income for the liberalization scenario

<b>- Relative inequality (scale invariant)</b>		<b>FFI</b>	<b>FFI + nonfarm income</b>
Gini coefficient of baseline income	$G_x$	0.377	0.290
Gini coefficient of scenario (after policy change)	$G_y$	0.966	0.571
Concentration coefficient of scenario	$C_y$	0.611	0.359
Concentration coefficient of support (base income – scenario income)	$C_B$	0.278	0.230
Average rate of support (support/base income)	s	0.70	0.54
Total redistributive effect	R	-0.589	-0.281
Index of re-ranking	H	-0.356	-0.212
Index of vertical equity	V	-0.231	-0.069
Index of progressivity of support	P	-0.099	-0.060

Note: Gini and concentration coefficients are estimated using the *sgini* Stata command developed by Van Kerm (2009).

Source: Own calculations.

<sup>7</sup> Correlation coefficient: -0.09.



#### **4. SUMMARY AND CONCLUSIONS**

In our paper we account for distributional effects of agricultural policy on income among western German farms. The analysis is based on results of different scenarios calculated by an integrated modelling system for the year 2015. This allows us to include incentive effects that occur due to a liberalization of the agricultural sector. To measure the distributional impacts of liberalization we use a method based on the comparison of Gini indices that distinguishes between vertical and re-ranking effects. There are remaining deficiencies of the analysis. Significant structural changes can be expected from liberalization of the agricultural market, which cannot be depicted in the current model specifications (Deppermann et al., 2010). Second, because of grouping farms and using average income for the analysis, it is possible to account for between-group inequality only.

Our results differ depending on the normative decision of the measure of inequality. In relative terms, liberalization of the western German agricultural sector leads to a more unequal distribution of FFI, whereas in absolute terms a liberalized market provides a more equal situation. In both cases, significant re-ranking effects occur which lead us to support Allanson's (2006, p. 126) conclusion, drawn for Scotland, that agricultural support is inefficient as a redistributive tool. One reason for re-ranking might be the commodity based organization of agricultural support programs. When nonfarm income is also included, we find that the overall unequalizing effect (in relative terms) of liberalization is significantly reduced. This is another reason to conclude that agricultural support is inefficient as a redistributive tool: income policy should be related to total household income and not to isolated income from any single source.

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