The effect of agricultural policy reforms on income inequality in Swiss agriculture - An analysis for valley, hill and mountain regions

Nadja El Benni, Robert Finger
Agri-Food and Agri-Environmental Economics group, ETH Zürich, Switzerland,
elbennin@ethz.ch

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Nadja El Benni, Robert Finger
Agri-Food and Agri-Environmental Economics group, ETH Zürich, Switzerland,

Abstract
We analyse the development of income inequality in Swiss agriculture for the period 1990-2009. To this end, Gini coefficients are estimated using FADN data. Furthermore, we estimate concentration ratios and Gini elasticities for market income, direct payments and off-farm income. Our analysis is separated for the three production regions in Swiss agriculture: valley, hill and mountain regions. This study is motivated by the fact that Swiss agricultural policy reforms resulted in dramatic changes of the importance of different income sources in the here considered period. Our results show that household income inequality increased only slightly between 1990 and 2009. Furthermore, agricultural policy reforms affected the income inequality differently in the considered production regions. More specifically, the introduction of area-based direct payments in 1992 mainly affected the valley region. In contrast, the introduction of cross-compliance and abandonment of farm household payments in 1999 had stronger effects for farmers in the hilly and mountainous region. An increase in direct payment income would decrease household income inequality, especially in the mountain and hill regions. Also off-farm income reduces income inequality while market income increases inequality.

1 Introduction
One of the main objectives of agricultural policy is to maintain or even enhance the income of farm households. Different policy measures are available to reach this goal, including market support and farm-level direct payments. In Switzerland, market support has been reduced since the early 1990s. In contrast, direct payments became much more important over time. Currently, Swiss farmers are subsidized with direct payments amounting to around 2.5 billion Swiss Francs per year. With this increasing importance of direct payments for farm income, the responsibility of policy makers for the income distribution among farmers (i.e. income inequality) has increased considerably. Though this effect of changing income composition on income distribution within the farm population is of political importance, it has received little attention so far. Furthermore, most direct payment instruments within agricultural policy have (at least partially) the objective of redistributing income towards the neediest parts of the farming population (Mann, 2005). In Switzerland, particularly farmers in the hilly and mountainous regions are handicapped by adverse production conditions and face low incomes. Thus, these farmers are the main recipients of direct farm-level support. However, the kind of support for these farmers changed over time due to agricultural policy reforms (see El Benni and Lehmann, 2010, for details).

Based on this background, the goal of this paper is to measure the effect of Swiss agricultural policy reforms on the distribution of agricultural income. More specifically, these effects are estimated within three different agricultural production regions of Switzerland (the valley, the hilly and the mountainous region) that are characterized by different natural production constraints.

In our analysis, we use FADN data from 1990 to 2009 to measure the distributional effects of changing agricultural policies on total household income levels. Using the Gini decomposition approach of Lerman and Yitzhaki (1985), marginal effects of different income sources on the income distribution are calculated for each region. The here presented results can be used by policy makers to examine the

distributional effects of changing agricultural policies and to adjust support mechanisms in the specific regions.

The remainder of this paper is structured as follows. In section 2, the main developments of Swiss agricultural policy between 1990 and 2009 are described. Subsequently, the data and methods used in this paper are presented in the 3rd and 4th section. In the 5th, section the effects of agricultural policy reforms on the income distribution of households located in the valley, hilly, and mountainous regions are explored. Finally, section 6 summarizes and discusses the results.

2 Governmental support for Swiss farmers between 1990 and 2009

Swiss agricultural policy faced two significant reform steps in 1992 and 1999. In the pre-reform period in the early 1990s, market price supports maintained output prices at high levels. Farm-level supports were additionally provided to farmers that were faced by adverse production conditions in the hilly and mountainous regions of Switzerland. These measures included farm household payments (comparable to single farm payments) and animal head based payments but were abandoned with the second reform step in 1999. Also farmers in the valley regions received some of these support payments but to a negligible extent regarding total farm income (see Rieder and Anwander Phan-Huy, 1994, for details).

With the first policy reform step in 1992, area- and animal unit based direct payments were introduced for the first time and market (i.e. price) support was reduced significantly. Income related goals of agricultural policy could therefore also be achieved using decoupled direct payments (FOA, 2007). Another policy objective at that time was to support environmental-friendly production systems. To this end, an integrated production (IP) program was made available for voluntary participation of farmers. The next important reform step started in 1999, and further reduced market support. Moreover, farm-level supports were divided into general and ecological direct payments. Integrated production became an obligation to receive general direct payments (i.e. the direct payment system was based on a cross-compliance approach). The most restrictive baseline criteria to become eligible for direct payments, was the set-aside of seven percent of their farmland as ecological compensatory area (Mann, 2003). Within the general direct payments, farmers of the hilly and mountainous region are specifically supported by area-based hillside payments and animal unit based payments (compensating for adverse production conditions). Furthermore, farmers can voluntarily apply to several ecological direct payments without any regional restriction (see El Benni and Lehmann, 2010, for details). In 2009, 60.5% of all (general and ecologic) Swiss direct payments go to farmers in the hilly and mountainous region. General direct payments make up 79%, 82% and 87% of all direct payments received by farmers located in the valley, hill and mountain region, respectively (FOA, 2010).

3 Data

In our analysis, we use farm level income data of the Swiss National Farm accounting Network (FADN) that covers the period 1990 to 2009. Total household income is defined as gross household income minus total production costs, labour costs and interest on debt and land. This total household income is reconfigured into off-farm income, income from direct payments and market income. The latter is calculated as the difference between on-farm income and direct payment income and thus also contains subsidies to farmers through government market interventions (e.g. price support). To inference from the here used sample data to the entire farm population in Switzerland, we use weights for each farm, which are provided with the FADN data. These weights are based on the farm size, the farm production system, and the region[1]. In our analysis, we consider three subsamples, i.e. farmers producing in the valley, the hilly and the mountainous regions of Switzerland. To exclude extreme values within each

[1] The methodology of sample selection and details of weighting are presented in FAT (2000).

subsample, the 2.5% households at the top and bottom end of the total household income distribution were excluded from the analysis. This leads to average (over all years) sample sizes of 1646 farms in the valley, 979 farmers in the hill and 838 in the mountain regions. Taking the up-scaling of the sample based on farm-level weights into account, these sample sizes represent a farm population of 23994, 14355, and 13855 farmers in the valley, hilly and the mountainous regions, respectively. The definition of regions (valley, hill, mountains) is based on climatic and topographic conditions (LZV, 2008) and is provided with the FADN data.

4 Method

The Gini coefficient is a commonly used measure in income inequality research (see El-Osta et al., 1995, Keeney, 2000, Mishra et al., 2009, Schmid et al., 2006, von Witzke and Noleppa, 2007 for applications in agriculture). The Gini coefficient measures the relative income inequality and ranges between 0 and 1. If household income is totally equal distributed (i.e. all farms have the same income) the Gini coefficient is 0. However, this coefficient increases if the income distribution becomes more unequal[2]. To estimate the Gini coefficient, household income Y is assumed to be a random variable, distributed with mean μ over the farm population. With F(Y) being the cumulative distribution function of household income and cov denoting the covariance, the Gini coefficient of relative income inequality, G, can be written as follows Stuart (1954):

$$G = 2\,\mathrm{cov}\,\frac{[Y, F(Y)]}{\mu} \tag{1}$$

To measure the effect of different income sources on aggregated income inequality, we apply the Gini decomposition approach of Lerman and Yitzhaki (1985), which is an extension of the approaches of Fei et al. (1978) and Pyatt et al. (1980). Using this method, total household income is defined as the sum of incomes from k different sources Y_k (e.g. direct payments and off-farm income). $F(Y_k)$ denotes the cumulative distribution function of the income source k under consideration. The decomposed Gini coefficient can be written as follows:

$$G = \sum_{k=1}^{K} \frac{\mathrm{cov}[y_k, F(Y)]}{\mathrm{cov}[y_k, F(Y_k)]} \times \frac{2\,\mathrm{cov}[y_k, F(Y_k)]}{\mu_k} \times \frac{\mu_k}{\mu} \tag{2}$$

$$G = \sum_{k=1}^{K} R_k \times G_k \times S_k \tag{2a}$$

The Gini correlation R_k (Equation 2a) is defined as the covariance between the kth income component and the cumulative distribution of total income, divided by the covariance between the kth income component with its own cumulative distribution (Pyatt et al., 1980)[3]. G_k is the Gini coefficient of the kth income source, showing how income from the specific source is distributed within the population. The share of the kth income source on total income is given by S_k. R_k times G_k yields the concentration ratio (or Pseudo-Gini coefficient) C_k. It measures how income from each source is transferred across a population ranked with respect to the level of total income received:

$$C_k = \frac{\mathrm{cov}[y_k, F(Y)]}{\mathrm{cov}[y_k, F(Y_k)]} \times \frac{2\,\mathrm{cov}[Y_k, F(Y_k)]}{\mu_k} = \frac{2\,\mathrm{cov}[y_k, F(Y)]}{\mu_k} \tag{3}$$

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[2] Perfect inequality (i.e. a Gini coefficient of 1) is reached if a single household generates the entire population income and all other households receive no income.

[3] The Gini correlation ranges between -1 and +1. If R_k is positive (negative), the income of the kth income component increases (decreases) with increasing total income. If R_k is 0, the income source k does not contribute to total income inequality.

The Pseudo-Gini coefficient C_k is 0 if all income groups receive an equal amount of income of the given income component (Pyatt et al., 1980). C_k is negative if income from a specific source accrues mainly to the households in the lower tail of the distribution of total income, and is positive, if richer households receive a large proportion of the income from the specific income component. A concentration ratio that is larger than the Gini coefficient of aggregate income proves that the income component in question has had an unequalising effect on the observed aggregate income distribution (Keeney, 2000).

A further focus of our analysis is to estimate the effect of specific income sources on the distribution of total household incomes. To measure this effect of a specific income component on aggregated income inequality, the Gini elasticity is calculated following Lerman and Yithzaki (1985). The Gini elasticity shows how the Gini coefficient would change with a marginal percentage change in the mean income of the specific income component. Thus, the Gini elasticity η_k can be used to estimate, for instance, the effect of a 1% increase in direct payments on the Gini coefficient of household income. By assuming that the internal ratio between total income distribution and income source remains undisturbed, the rate of change of the Gini coefficient is derived as follows:

$$\eta_k = \frac{\mu_k}{G} \times \frac{dG}{d\mu_k} = \frac{1}{G}\left[\frac{\mu_k}{\mu}(C_k - G)\right] \tag{4}$$

The Gini elasticity is larger (smaller) than 1 if the amounts received under the specific income component raise more (less) than proportional to total household income. In case of unit elasticity, the distribution of income from a particular income source is proportional to the distribution of total income, and thus, the concentration coefficient and Gini coefficients coincide (Keeney, 2000, Podder, 1995).

In order to draw statistical inference from the here calculated point estimates for Gini coefficients, Gini elastiscities and Pseudo-Ginis, we construct 95% confidence intervals of these estimates using non-parametric bootstrap (see DiCiccio and Efron, 1996, for details). To this end, the above described values are estimated for 999 data replicates that are generated by sampling with replacement from the initial datasets (after trimming and weighting). Furthermore, we use the confidence intervals to test for significant differences between different zones, though we are aware that tests based on overlapping confidence intervals is a very conservative way of hypothesis testing (Schenker and Gentleman, 2001).

In the presence of negative incomes the here presented Gini coefficient may exceed unity and the estimates of the elasticities are analytically correct but biased upwards (Boisvert and Ranney, 1990). Even if methods exist to estimate Gini coefficients that account for negative incomes (Chen et al., 1982) these coefficients cannot be decomposed by income source (Boisvert and Ranney, 1990) and their interpretation is difficult (van de Ven, 2001). Hence, by using the here presented Gini decomposition approach, the marginal effects of different income components on income inequality may be biased upwards. However, this does not affect the qualitative policy implications derived from our analysis (e.g. Boisvert and Ranney, 1990).

5 Results

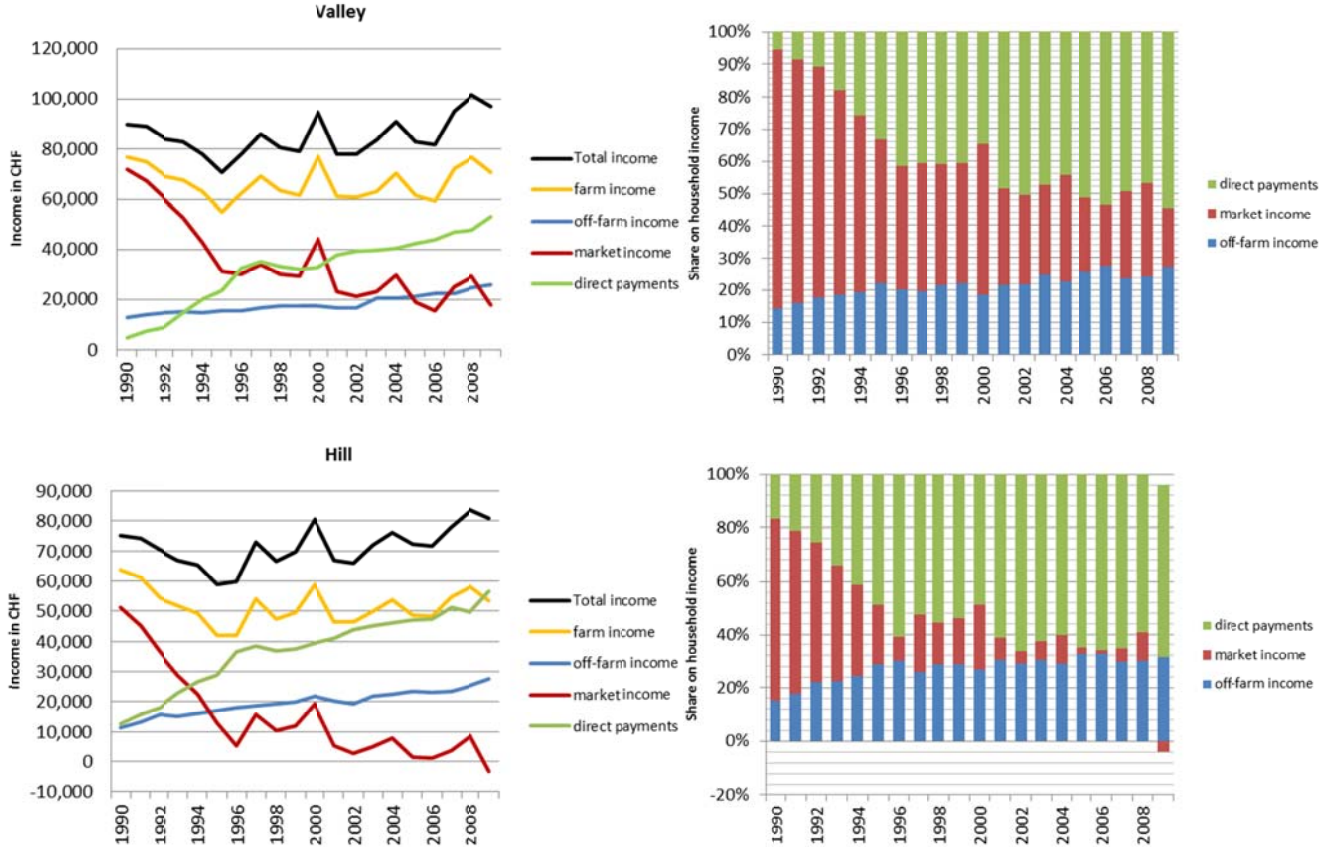
In this section, the effect of the agricultural policy reforms on income, income composition and income distribution are presented. For each region (valley, hill, mountain), the Gini coefficients are decomposed into off-farm income, market income and income from direct payments. The hypothesis investigated in this section is that changes in total household income inequality can be attributed to particular agricultural policy reforms. More specifically, we analyse if the change from market support to direct payments affected the inequality of income distributions. Due to the particular focus of Swiss agricultural policy on farms with adverse production conditions, we expect furthermore that the effect of policy changes is different in the three considered regions.

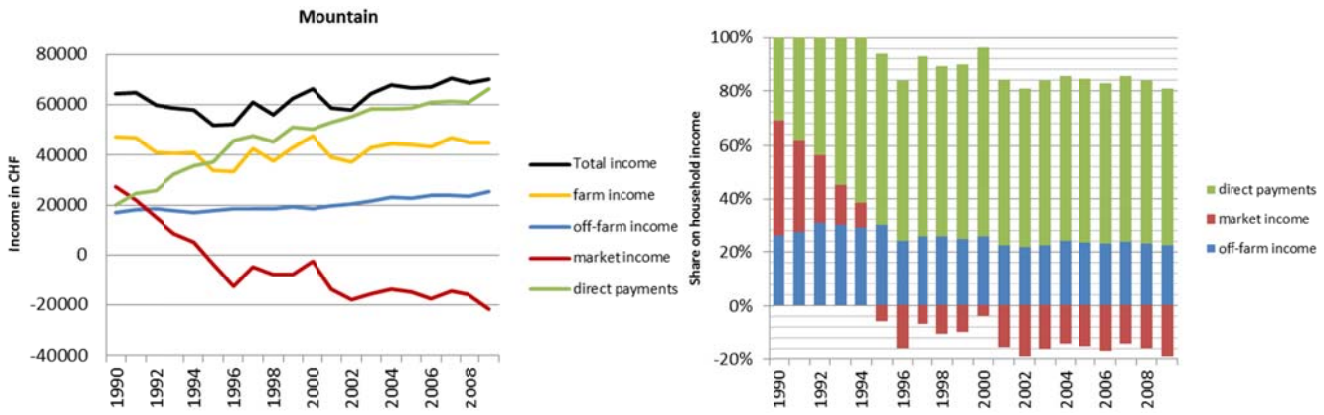
5.1 The effect of agricultural policy reform on income and income composition

Figure 1 shows the development of the different income sources for each region between 1990 and 2009. It shows that farms located in the valley regions generate the highest household incomes. Compared to the farmers in the hill and mountain regions, valley farmers have in average 20% and 38% higher household incomes in 2009 respectively. For farm income, differences between the regions are even more distinct. Valley farmers generate 33% and 58% higher farms incomes in 2009 compared to farmers located in the hilly and mountainous regions, respectively. Figure 1 shows furthermore, that the reduction of market support in the early 1990s had a higher impact for farmers in the valley and hilly regions, compared to those in the mountain region. This effect is indicated by a stronger decrease in absolute household and farm income levels in these regions. Farm income is still the most important income source for farmers, but off-farm income became increasingly important over time, in particular for farmers in the hilly and valley regions. In contrast, farmers of the mountainous regions increased their off-farm income only slightly over time.

Separating farm income into income from direct payments and market income shows that especially farmers of the mountain and hill regions depend on direct payments. In contrast, valley farmers receive the lowest absolute amounts of these farm-level supports. Over all years considered, valley farmers generate the highest market incomes, even if the importance of this income source for household income decreased for all regions. Interestingly, Figure 1 shows that since 1995 farmers in the mountain regions lose money by agricultural production (i.e. costs exceed revenues from agricultural production). Since 2001 approximately 25% of the direct payment support is needed by mountain farmers to compensate these market losses.

Figure 1: Income and income composition in the valley, hill, and mountain regions 1990-2009





5.2 The effect of agricultural policy reforms on the income distribution

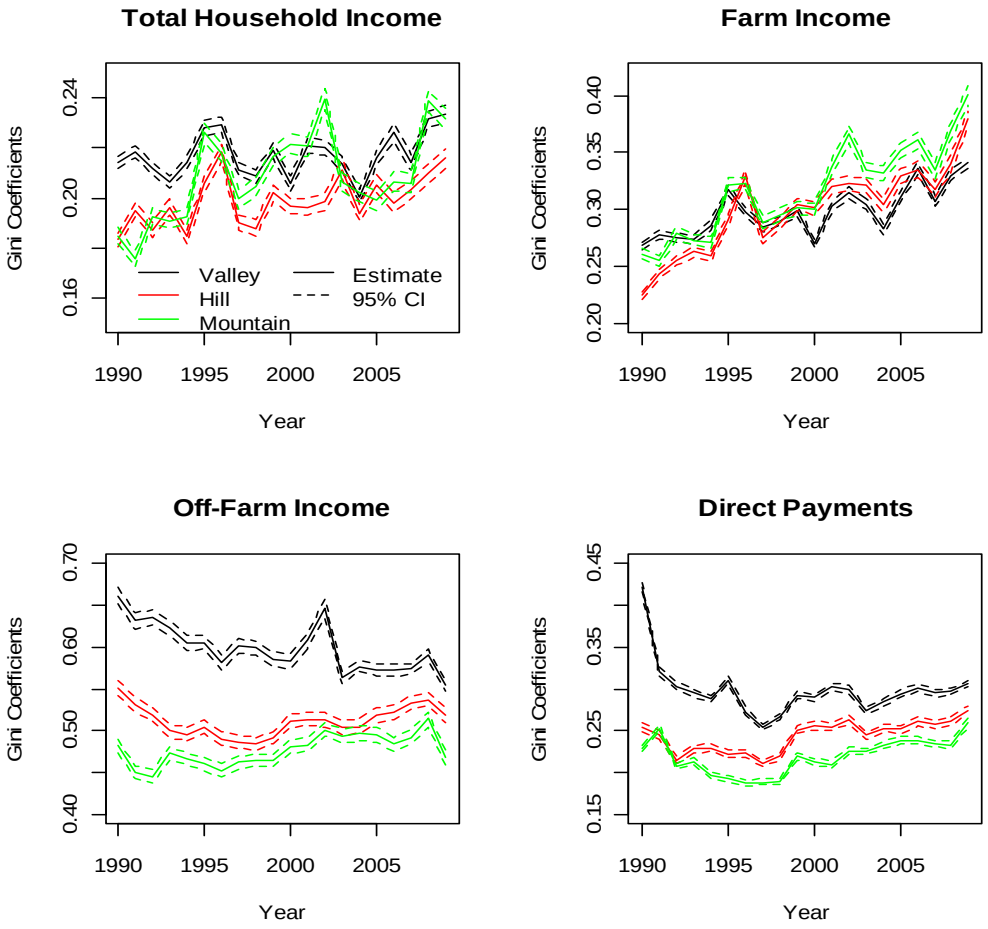
The Gini coefficients

Figure 2 shows the estimated Gini coefficients as well as 95% confidence intervals for the different income sources for the valley, hill, and mountain regions between 1990 and 2009. It shows that, in general, farm income is less equally distributed compared to household income. Moreover, the inequality of farm income increased over time. For all regions, household income inequality increased only slightly between 1990 and 2009. Thus, though agricultural policy reforms have significantly changed income compositions over time (Figure 1), total farm household incomes remained relatively equally distributed. Over most of the years considered, total household income inequality is significantly higher for farmers in the valley region, compared to those in the hilly regions. No clear differences can be observed regarding the mountain farmers. In 1990, farm income inequality in the valley region was significantly higher than in the hilly region. This relation changed over time, and farm income inequality is currently significantly higher in the hilly and mountainous regions than in the valley regions.

The bottom-left graph in Figure 2 shows that off-farm income is highly unequally distributed compared with all other income sources, particularly for valley farmers (large Gini coefficients). On the one hand, this might reflect different off-farm employment opportunities across Switzerland. On the other hand, this also shows heterogeneous preferences and needs of farmers to generate additional income off the farm. Over time, off-farm income became more equally distributed within the valley regions, which shows that an increasing number of farmers rely on off-farm income sources. In contrast, the inequality of off-farm income distribution in the mountain regions increased slightly over time[4]. With the introduction of area-based direct payments in 1992 (cp. Section 2), direct payments became more equally distributed within the population of valley farmers. In contrast, only a slight decrease in inequality of direct payments can be observed for hilly farmers and virtually no effect of the reform can be observed for mountain farmers. However, since the second agricultural policy reform step in 1999, direct payments became more unequally distributed especially in the hilly and mountainous regions. This might be explained by the fact that the farm household payments were abandoned. Another important point of this reform step was that direct payments were based on a cross-compliance approach. However, the association of specific policy changes within one reform step to the distribution of direct payments within the hilly and mountainous regions is not possible.

[4] This might show changes in the off-farm employment opportunities for mountain farmers over time but is not further investigated in this study.

Figure 2: Gini coefficients for household, farm, off-farm and direct payment income



The Pseudo-Gini coefficients

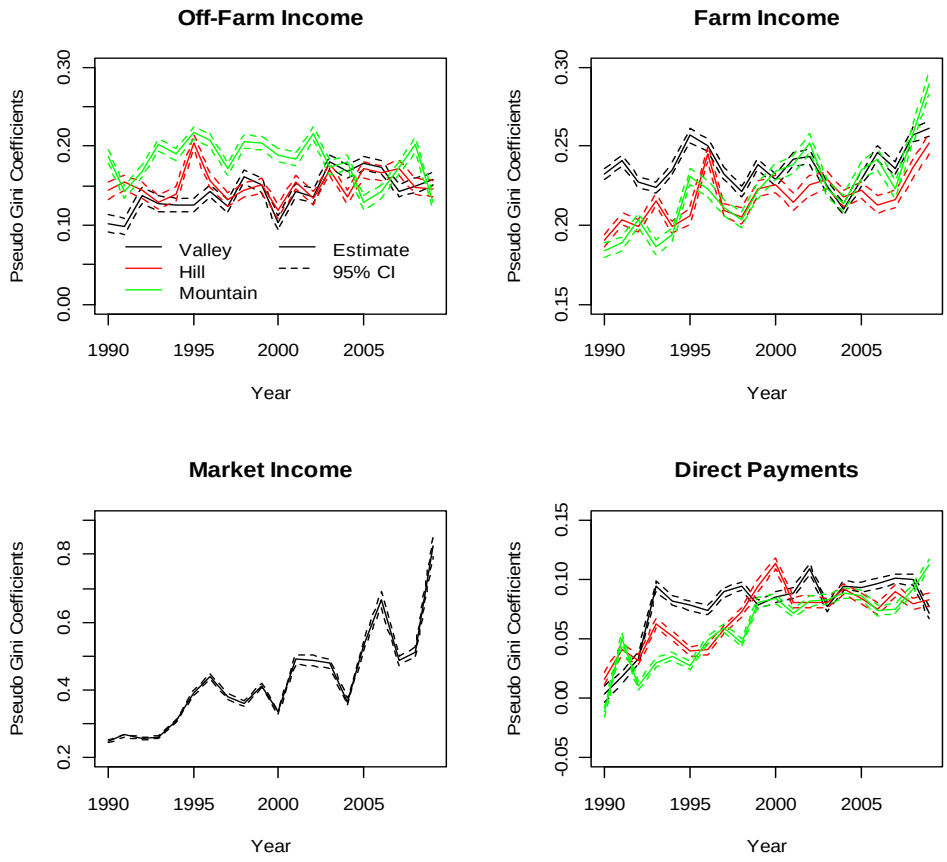
Figure 3 depicts the changes in the Pseudo-Gini coefficients of off-farm and farm income as well as of income from direct payments and market income. Pseudo-Gini coefficients that are larger than 0 show that income from the specific income source is mainly distributed to farmers in the lower tails of the total household income distribution.

The Pseudo-Gini coefficients for off-farm income presented in figure 3 show that mainly farmers with (on average) higher household income level generate off-farm income (positive Pseudo-Gini coefficients). This shows the importance of off-farm for total household income levels. Between 1990 and 2002 the Pseudo-Gini coefficients were significantly higher for mountain farmers compared to valley farmers. However, over time, the importance of off-farm income for total household income increased also for farmers in the valley regions. Currently, no significant differences between the regions with respect to the Pseudo-Gini coefficients for off-farm income can be observed. Figure 3 shows furthermore that farm income is mainly generated by farmers with higher household income levels. In the valley region, farm income had a significantly stronger effect on total household income level in the 1990s compared to the other regions. While there are still significant differences in most years between valley and mountain farmers, these differences became much smaller over time. This is the result of decreasing market prices.

Decomposing farm income into income from direct payments and market income shows that market income is increasingly generated by farmers with high household income levels. Because of extreme

results (outside the range of -1 to +1), only the Pseudo Gini coefficients for market income for valley farmers are depicted in figure 3. These extreme Pseudo Gini coefficients are caused by an increasing amount of farmers that lose money by agricultural production (i.e. the values for market income become negative). This is especially true for farmers in the hilly and mountainous regions in Switzerland but also for farmers in the valley regions.

Figure 3: Pseudo-Gini coefficient in the valley, hill and mountain regions 1990-2009



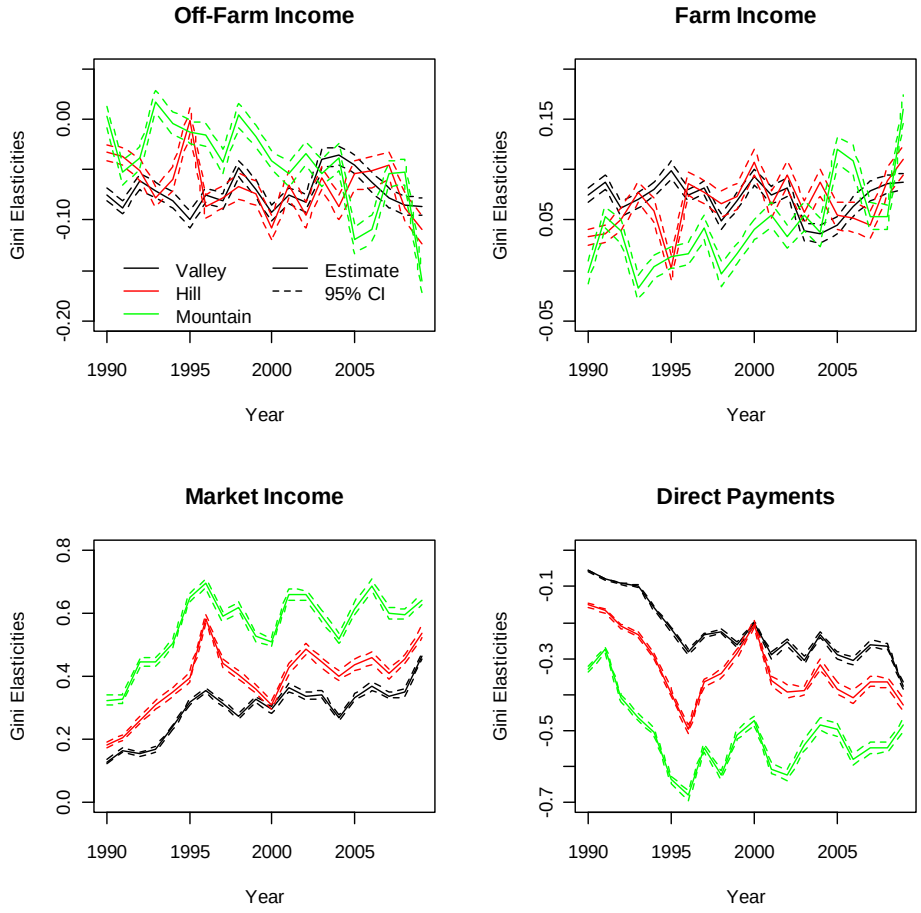
In contrast to market income, income from direct payments is more equally distributed with respect to total household income level within all three regions. Nevertheless, the Pseudo-Gini coefficients of direct payments increased over time. This shows that governmental support increasingly determines the distribution of household income. For the mountain region, figure 3 shows furthermore that direct payments mainly supported farmers with (on average) lower household income levels in 1990. The agricultural policy reform in 1992 (i.e. the introduction of area-based direct payments) affected especially farmers in the valley regions. This is shown by the strong increase in the Pseudo-Gini coefficients at that time. The distributive effects of the newly introduced direct payments with respect to total household income level can be explained by their link to the production factor land. While market support indirectly advantages larger farms, area-based direct payments directly support farmers with larger farm size. In this sense, the distributive effects of the “old” market support based agricultural policy was to a certain extent overtaken by the ”new” decoupled agricultural policy. This effect of decoupled direct payments was already shown by von Witzke and Noleppa (2007) and Mann (2005). Our analysis shows that this effect became even more obvious in the comparison between the different regions. In the hilly and mountainous regions, farms are in average much smaller than in the valley regions. Thus, the agricultural policy reform in 1992 had, in these regions, a much smaller effect on the

distribution of direct payments with respect to total household income level. In contrast, farmers within these regions were much more affected by the changes in 1999 (compared to valley farmers). The abandonment of per farm household payments and the introduction of cross-compliance standards led to an increase in the Pseudo-Gini coefficients.

5.3 The marginal effects of different income sources on the distribution of household income

Figure 4 depicts the changes in the Gini elasticities of the different income sources and regions considered. Values below (above) 0 show that an increase of the income source under consideration would reduce (increase) total household income inequality (i.e. the Gini coefficient). Figure 4 shows that an increase in on-farm income would increase inequality of (total) household income. In contrast, an increase of off-farm income and income from direct payments would decrease total household income inequality. The marginal effect of direct payments on the distribution of total household income is stronger than the effect of off-farm income (shown by the larger absolute values of Gini elasticities). Furthermore, the results shown in the bottom left graph of Figure 4 imply that the increase in market income would increase total household income inequality. Note that the marginal effects of market income on the distribution of total household income are overestimated because of the high amount of negative values especially in the hilly and mountain regions. This overestimation does, however, not affect the qualitative interpretation of these results.

Figure 4: Gini elasticities in the valley, hill and mountain regions 1990-2009



Regarding the marginal effects of off-farm income on household income distribution, significant differences between the valley and mountainous region can be observed between 1990 and 2001. The

income inequality decreasing effect of off-farm income was stronger in the valley compared to the mountain regions. Currently, no general significant differences between the regions exist. Our numerical results (not shown)[5] indicate that, for instance, a 1% increase in off-farm income within the valley region would have reduced the Gini coefficient by 0.07% in 1990 and by 0.09% in 2009. In contrast, a 1% increase in off-farm income in the mountain region would have had no effect on the Gini coefficient of total household income in 1990 but would decrease income inequality by 0.16% in 2009. Furthermore, the Gini elasticities increased for the mountain and hilly region but not for the valley region. This can be explained by the increasing importance of this income source for farmers in the hilly and mountainous region.

The Gini elasticities of direct payments show that an increase in governmental payments would have the strongest effects (on reducing household income inequality) in the mountain region. The differences between the regions are significant, except for the year 2000 considering the hilly and valley region. The here presented Gini elasticities of direct payments show that in the valley region an increase in direct payments by 1% in 1990 would have reduced household income inequality by 0.05% and by 0.38% in 2009. In the mountain region a 1% increase in direct payments would have reduced the Gini coefficient by 0.33% in 1990 and by 0.48% in 2009.

6 Summary and Conclusion

Agricultural policy reforms in Switzerland affected the income distribution within the valley, hilly, and mountainous regions differently. In the pre-reform period with high market prices and direct payments for farmers producing under adverse production conditions, direct payments were equally distributed in the hill and mountain regions, but unequally distributed in the valley region. With the first agricultural policy reform in 1992, market support was reduced and area-based direct payments were introduced. These payments were made available to all farmers and, compared to the pre-reform period, were therefore more equally distributed especially within the valley region. In contrast, this 1992 reform step did not affect the distribution of farm-level support within the hill and mountain region.

With the agricultural policy reform in 1999, the area-based direct payments were obliged to environmental-friendly production standards (cross compliance obligations) and the farm household payments were abandoned. In contrast to the first reform steps in 1992, these changes also affected farmers in the hill and mountain regions because direct payments became less equally distributed within these regions. Also in the valley regions these changes led to an increase in direct payments income inequality but inequality decreased again in the subsequent years (in contrast to the hill and mountain regions). These results might show that farm household payments are the better instrument to redistribute income towards the neediest parts of the farming population than area-based direct payments. This is because small farm operations are in general those with lower incomes (e.g. von Witzke and Noleppa, 2007) and those that receive the lowest amount of area-based direct payments. Therefore, the income gap between farmers increases with the switch from per farm household to area-based direct payments. Agricultural policy should consider this effect on income distributions if opting for either measure of farm support.

Another result of the agricultural policy reform in 1992 was that mainly farmers with in average higher household income levels were supported. This is true for all farmers but especially for those in the valley regions. This can be explained by the link between direct payments and farm size via area-based direct payments. However, larger farmers were also advantaged by market support measures, because they usually produce higher output volumes. Hence, the distributive effects of governmental support are similar between market support and direct payment support to a certain extent. However, we expect that

[5] Detailed results are available from the authors upon request.

restrictions for the reception of direct payments[6] lower their distributive effects with regard to total household income levels, compared to the effect of market support measures.

With the reductions of market support, the mean household income levels in Swiss agriculture first decreased but re-increased later. Currently, income levels are even higher than in the pre-reform period. However, household income inequality increased over time, especially for farmers in the mountain region. This is a result of an increasing number of farmers that generate negative market incomes. The income gap between farmers that earn money on the market and those that lose money by agricultural production increased over time. This is also shown by the strong increase in farm income inequality, especially in the mountain regions. As a result of decreasing market income, off-farm income is increasingly used by farmers to maintain household income levels. This is especially true for farmers in the valley regions, while farmers in the hill and mountain regions were less able to increase off-farm income. Our results show that an increase in direct payments and off-farm income would decrease income inequality across farmers. In contrast, an increase of market income would increase inequality. These findings are in line with the results of Keeney (2000), El-Osta et al. (1995), and Mishra et al. (2009). Due to its high share on household income, an increase in direct payments would lower income inequality, especially in the mountain regions. .

The results derived from the here presented analysis show that the effects of agricultural policy reforms differ between regions and that farmers are increasingly dependent on direct payments to maintain their household income. However, income goals cannot be achieved satisfactorily by the current policy because of two reasons. First, an increasing number of farmers lose money by agricultural production which wastes (tax-payers) money. Second, this policy reduced the incentives to release agricultural land. Thus, the number of farmers with negative market incomes is likely to increase if agricultural price levels decrease further in the future. While there are several other objectives of agricultural policy beside income, it should be kept in mind, that economic reasons are the main driving forces for structural change. An increase in the competitiveness of farmers would reduce the responsibility of policy makers regarding the distributional effects of direct payments.

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References

Boisvert, R.N. and Ranney, C. (1990). Accounting for the importance of non-farm income on farm family income inequality in New York. *Northeastern Journal of Agricultural Economics* 19: 1-11.

Chen, C.-N., Tsaur, T., Rhai, T.S. (1982). The Gini coefficient and negative income. *Oxford Economic Papers* 36: 473-476.

Di Ciccio, T.J. and Efron, B. (1996) Bootstrap Confidence Intervals. *Statistical Science* 11(3): 189-212.

El Benni, N. and Lehmann, B. (2010). Swiss agricultural policy reform: landscape changes in consequence of national agricultural policy and international competition pressure. In: Primdahl, J. and Swaffield, S. (eds), *Globalisation and Agricultural Landscapes - Change Patterns and Policy trends in Developed Countries*. Cambridge University Press, Cambridge, 73-94.

El-Osta, H.S., Bernat, G.A., Ahearn, M.C. (1995). Regional Differences in the Contribution of Off-Farm Work to Income Inequality, Agricultural and Resource Economics Review 24(1): 1-14.

FAT (2000). Neue Methodik für die Zentrale Auswertung von Buchhaltungsdaten an der FAT, Eidg. Forschungsanstalt für Agrarwirtschaft und Landtechnik (FAT). http://www.agroscope.admin.ch/betriebs-wirtschaft/ 04362/04363/04379/index.html?lang=de (last accessed 15th February)

[6] For instance, Swiss farmers receive direct payments until the age of 65 (see more details in El Benni and Lehmann, 2010).

Fei, J.C.H., Ranis, G., Kuo, S.W.Y. (1978). Growth and the Family Distribution of Income by Factor Components. *The Quarterly Journal of Economics* XCII (Feb. 1978): 17-53.

FOA (2007. 125 Jahre Bundesamt für Landwirtschaft, Swiss Federal Office for Agriculture, Bern, Switzerland.

FOA (2010). Agricultural report, Swiss Federal Office of Agriculture, Bern, Switzerland.

Keeney, M. (2000). The Distributional Impact of Direct Payments on Irish Farm Incomes. *Journal of Agricultural Economics* 51(2): 252-263.

LZV (2008). Verordnung über den landwirtschaftlichen Produktionskataster und die Ausscheidung von Zonen, Stand 1. Januar 2008. http://www.admin.ch/ch/d/sr/912_1/index.html (last accessed 15th February)

Lerman, R.,I. and Yitzhaki, S. (1985). Income Inequality Effects by Income Source: A New Approach and Applications to the United States. *The Review of Economics and Statistics* 67(1): 151-156.

Mann, S. (2003). Doing it the Swiss Way. *EuroChoices* 2(3): 32-35.

Mann, S. (2005). Implicit Social Policy in Agriculture. *Social Policy and Society* 4(3): 271-281.

Mishra, A., El-Osta, H., Gillespie, J.M. (2009). Effect of agricultural policy on regional income inequality among farm households. *Journal of Policy Modeling* 31(2009): 325-340.

Podder, N. (*1995*). On the Relationship Between the Gini Coefficient and Income Elasticity. *Sankya: The Indian Journal of Statistics* 57 (Series B, pt.3): 428-432.

Pyatt, G., Chaunan, C., Fei, J. (1980). The Distribution of Income by Factor Components. *The Quarterly Journal of Economics* 95(3): 451-473.

Rieder, P. and Anwander Phan-Huy (1994). Grundlagen der Agrarmarktpolitik. Vdf Verlag, ETH Zürich, Switzerland.

Schenker, N. and Gentleman, J.F. (2001). On Judging the Significance of Differences by Examining the Overlap Between Confidence Intervals. *The American Statistician* 55(3): 182-186.

Schmid, E., Hofreither, M.F., Sinabell, F. (2006). Impacts of CAP Instruments on the Distribution of Farm Incomes – Results for Austria, Diskussionspapier DP-13-2006, Universität für Bodenkultur Wien.

Stuart, A. (1954). The Correlation Between Variate-Values and Ranks in Samples from a Continuous *Distribution*. *British Journal of Statistical Psychology* 7: 37-44.

Van de Ven, J. (2001). Distributional Limits and the Gini Coefficient. Research Paper Number 776, January 2001, Department of Economics, University of Melbourne/ Australia.

von Witzke, H. and Noleppa, S. (2007). Agricultural and Trade Policy Reform and Inequality: The Distributive Effects of Direct Payments to German Farmers under the EU`s New Common Agricultural Policy. Working Paper No. 79/2007, Humboldt-Universität zu Berlin.